Bay Area Air Quality Management District
939 Ellis Street
San Francisco, California 94109

APPROVED MINUTES

Advisory Council Technical Committee
9:00 a.m., Monday, June 11, 2007

1. **Call to Order- Roll Call.** Chairperson Altshuler called the meeting to order at 9:08 a.m. Present: Sam Altshuler, P.E., Chairperson, Louise Bedsworth, Ph.D, John Holtzclaw, Ph.D, Robert Bornstein, Ph.D, Mr. Kraig Kurucz, (9:13 a.m.), Mr. William Hanna, (9:15 a.m.).

2. **Public Comment Period:** There were no public comments.

3. **Approval of Minutes of April 16, 2007.** Approval of minutes was deferred pending the Committee members input with regards to Dr. Bart Ostro's presentation on "The Effects of Fine Particle Species on Daily Mortality and Morbidity in California" that were not captured on the cassette tape on the day of the meeting.

   Also the Committee requested that staff make changes on the comparison grid for the MATES and CARE programs. Changes and clarification requested regarding: A) Lube Oil Measurement; B) PM sizing; C) Acrolein trend. Clarify Grid: 4/2km and Grid: 2km as well as the term temporary vs. mobile sites.

4. **Presentation on "New Data on Heavily Traveled Secondary Roadways and their Mitigation":** Dr. Tom Cahill, Professor of Physics and Atmospheric Sciences, University of California Davis delivered to the Committee a presentation on "New Data on Heavily Traveled Secondary Roadways and their Mitigation." Dr. Cahill worked off of a 70 slide presentation. Key topics discussed included:

   - Information on health impacts of aerosols; the role of very fine and ultra fine particles.
   - Information on vehicular emissions; the increasing dominance of spark emission pollutants by mass; the higher toxicity of gasoline automobile car exhaust due to the presence of PAHs.
   - New information on air quality near freeways and secondary roadways

   Dr. Cahill noted that his presentation was relatively new and was comprised of data gathered from different sources. Dr. Cahill's project in the Sacramento area is supported by the Sacramento Metropolitan Air Quality Management District. Dr. Cahill stated that the results of the Roseville study were not available, but would be soon. The Air District will receive the results when finalized.

   Dr. Cahill started the discussion with current information about the inhalation of particulate matters, slides 4 and 5. Dr. Cahill directed the committees' attention to

the health impact of ultrafine PM and how various sizes of PM are deposited in the lung and airways. Further, the ultrafine PM is laced with PAHs attributable to engine lube oil. Dr. Cahill pointed that with data on stroke ischemia heart disease result of 60% rise in the Central Valley, increasing from north to south, Shasta to Kern, slide 9. Dr. Cahill also added that according to the Health Effects Tasks Force Group meeting of January 2007, the health impacts include; short term trigger of asthmatic attacks, lung damage seen in children and increased mortality in the elderly. The Health Effect Task Force is an early warning group that meets every two months.

Interest in the study of PM air pollution near secondary roadways emerged from observing two lane streets in rural areas in Sacramento that accommodate about 65,000 vehicles a day that affected school and residents nearby. The roadways had expanded to about nine lanes and three rail lines. Dr. Cahill stated that new information was derived for vehicular emissions through several recent research projects for on-road diesel and gas emission rates. 75% of PM 2.5 is attributable to organic emissions from diesel and gasoline vehicles, Slide 13. Dr. Cahill directed the committees' attention to research results reported by Desert Research Institute, (DRI) linking toxicity to emissions associated with engine lube oil. Dr. Cahill promised to update the existing presentation after the meeting and email a copy to the committee. Chairperson Altshuler asked about DRI's opinion on the toxicity in lube oil. In response, Dr. Cahill stated that lube oil from cars is 10 to 20 times more toxic than emission from lube oil from diesels. In response to Dr. Bedsworth's questions of whether burning too much lube oil indicates that a vehicle is not running well? Dr. Cahill stated that lubricating oil should not burn at all.

Dr. Cahill spoke about another study of zinc aerosol at Fresno during the Fresno Asthmatic Children's Environmental Studies (FACES). There were sparks of zinc from pesticides being applied to fields many miles away; as well as from fireworks in Fresno and the Bay Area. The zinc was measured along with other elements (phosphorous, sulfur, potassium, zinc) also found in the exhaust of diesel and gasoline engines.

New information on the toxicity of car exhaust showed that spark ignition car exhaust is more toxic than diesel truck or busses. Cars have more PAHs in their oil than diesels. Benzo-a-pyrene is the worst per mass. In response to Mr. Altshuler's question on why the Benzo-a-pyrene is the worst per mass, Dr. Cahill responded that Eric Fujiti's (DRI) theory is that the oil in small spark ignition vehicles exposes oil to conditions favorable for creating PAHs. Another point is that higher temperature in diesel combustion destroys the PAHs. Also Dr. Cahill reported CNG busses in Davis have about four times the ultra fine particles as normal diesel busses. When questioned by the committee, these busses were found to be old and not typical of state-of-the-art CNG engines sold today.

Dr. Cahill stated that the Roseville Railyard trains are the most toxic and rich in PAH, this study revealed that the trains buy cheap Nevada fuels that is rich in sulfur and travel into California; and the oils also never get changed.

In slide 56, Dr. Cahill showed how very fine and ultrafine PM have relatively high removal rates via diffusion if a surface is close; vegetation can provide such a surface. Dr. Cahill stated that Redwood vegetation was used in an experiment to show how they capture fine particles and ultra fine particles. As wind speed increase above 1 mile per hour, the vegetation increased its effectiveness in capturing PM.

Dr. Bornstein asked a question regarding the fraction penetrating vegetation on the graph because Dr. Cahill related the experiment to his previous results on thermal plume study. However, Dr. Bornstein clarified that the vegetation experiment is horizontal advection through the trees and thermal plume is vertical transport; therefore for real highway and low speed, with thermal affect, the material will not move horizontally to be filtered by the trees hence; the result cannot be combined. Dr. Cahill stated that his data was derived from sampling derived from Lake Tahoe. During the sampling, at night, the wind comes down the mountain. This bubble of air rises up about 100 meters every night and diffuses laterally outward and both sides of the highway. However Dr. Bornstein cautioned that the data should be used with care when relating it with thermal plume result because the physics are different.

Data of eight drum samplers, Slide 57 were taken from Arden Middle School and compared to the sample from Roseville Railyard; Dr. Cahill noted that the data showed that at a period of time, transport from the Bay Area caused pollution. Also with the result, the EPA region IX felt that the Roseville Railyard was as bad as Arden Middle School in Sacramento area. When the particles were measured, mass in coarser fractions showed Arden Middle School with less aerosol but when the mass finer fractions was measured, Arden Middle School rose in proportion to Roseville Railyard. The comparison also showed that for nickel, copper and zinc, there is more zinc at Arden Middle School than there is at Roseville Railyard, Slide 66.

In summary, Dr. Cahill stated that roadways in residential areas are the overwhelming contributor to all California Toxic Air Contaminants (TAC) impacts statewide, Slide 66. Most vehicular aerosols are from cars; car exhaust is more toxic than diesel exhaust per unit mass. Also freeways are less of an impact because there are fewer freeways than secondary roadways; they are generally better buffered from residences; the high traffic velocities induce better mixing and lofting of emissions, and the vehicles tend to be cleaner.

Dr. Cahill noted that since roadways, traffic, and toxic emissions cannot be eradicated; mitigation will be the line of action. The most important is mitigating from the source which include: 1) Roadway source improvement; cleaner engines, fuel, and new synthetic lubricating oils; also removal of gross emitting vehicles from roadways; reduce traffic via transportation alternative; 2) Roadway design options – “Complete streets”; highway design; cut section, tunnel cleaned, pollution

barriers- use waste heat and vegetation to loft and trap ultra fine particles; 3) Reduce transportation efficiency to residences; distance, pollution barriers.

Mr. Kurucz asked how the three measurement factors impact the measurement of particulate sizes, if there was any cascading factor. In response, Dr. Cahill noted that the measurement method called Multiple Oriface Uniform Deposit Impact (MOUDI) was developed by the University of Minnesota; a non rotating single stage factor that has ultra fine capabilities used mostly for chemistry though very hard to work with. The Drum sampler was used also as well as the Cad point factor and Advanced light source in Berkeley. Altogether, 81,000 analyses were done in the last six months. Particle counters was also used in the measurement.

Mr. Altshuler commented on his concern regarding lube oil, he stated, there should not be a generalization about natural gas having more oil emissions. The issue is that converted diesel engines to natural gas can be sucking oil down the valve guides but recent model Honda natural gas passenger car engine shows cleaner engines. He also added that when oil is being used it is evaporating not burning. Mr. Altshuler stated that oil is a big issue that relates to zinc, phosphorous, and should be added to the Air District's CARE program study.

Dr. Holtzclaw added that one of the major issues is the impact of certain urban design; high density areas of buses and cars using the road, there are also more lungs breathing those particles. Thus "Complete Streets" as mentioned in the presentation seems to be a good solution and will make people walk more and drive less.

Dr. Bornstein pointed that circulation should be clarified regarding the thermal effect of low wind speed at night and high wind effect, stating that the meteorology should be clearly stated.

Mr. Kurucz requested the full data of the critical graph that Dr. Cahill showed briefly on Roseville Railyard data be sent to the Technical Committee when completed. Mr. Kurucz also asked how reliable is the higher level model, in terms of validating recommendations? Dr. Cahill responded that using a better model will be helpful but the team does not have a better model at the moment. Dr. Bornstein added that the Monte Carlo model involves particles and sophisticated meteorology but the model that Dr. Cahill used had one wind thus particle model is usually driven by meteorological feel that has variation in space and time; this made the meteorology and dispersion transport captured in a more sophisticated way.

Mr. Altshuler presented to Dr. Cahill a token of appreciation for his trip and presentation to the Committee.

5. **Committee Member Comments/Other Business:** Mr. Hanna raised the issue he heard concerning Honda hybrid vehicles which should be serviced after 100,000 miles at the cost of $1,500 but it actually cost $5000 to recharge. The desirability of this model will be decreased by the cost for battery service replacement.

Mark Jacobson of Stanford will be presenting to the Committee; the topic of ethanol/ozone/public health as well as an update on black carbon and climate change.

Mr. Altshuler asked Mr. Hess if there is anything staff wants the Technical Committee to look into. Mr. Hess responded that after the summer recess, the staff will look into what the Council has completed with regards to assignment and look at what direction to take.

Staff member, Mr. Saffet Tanrikulu relayed to the Committee the following topics that might be of interest, 1) ammonia emission inventory; the Air District has a contract with STI who is developing ammonia emissions inventory for the Air District, the results may be in by October; 2) Trend Analysis for Ozone; two groups are working on this issue; Charles Blanchard (Consultant) and UC Davis; 3) Particulate Matter and episodes in the winter time and meteorology. The District is working with UC Davis on characterizing the meteorology; the result may be available by next year, 2008.

Dr. Bornstein stated that Mr. Bart Croes liked the work they did on the Cooling in the Coastal Area, however, Mr. Croes commented that the models cannot reproduce the downward trend in ozone observations solely by emission and reduction, thus he thought that perhaps the cooling that was observed in the Los Angeles area and the Bay Area might also be a factor in lowering ozone. Dr. Bornstein asked if the work that the staff is doing involved modeling and does the modeling fail to capture the magnitude of downward trend.

Dr. Bornstein promised to give the staff the results of the work that was done on 'The Cooling in the Coastal Area'.

Dr. Bornstein inquired if staff would be interested in the Committee focusing on shipping and aircraft emissions if there is someone specialized in that area.

Mr. Tanrikulu responded that staff has been looking into those emission issues.

Chairperson Altshuler thanked Mr. Hess for his leadership and support all these years, Mr. Hess will be retiring from the Air District in July.

6. **Time and Place of next meeting:** 9:00 a.m., Monday, August 6, 2007, 939 Ellis Street, San Francisco, CA 94109.

7. **Adjournment:** The meeting adjourned at 12: 08 p.m.

/s/ Chioma Dimude
Chioma Dimude
Acting Executive Secretary

Agenda:4

New Data on Heavily Traveled Secondary Roadways and their Mitigation

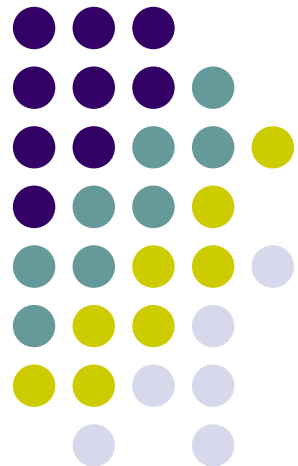
A presentation for the Bay Area AQMD

June 11, 2007

Thomas A. Cahill,

Professor of Physics and Atmospheric Sciences and Head, DELTA Group

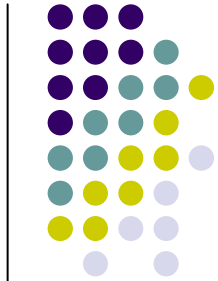
University of California, Davis



Why this sudden interest in secondary roadways?

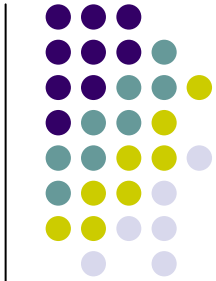
- Exacerbation of pre-existing conditions…
  - Increased population and roadway traffic, including increased traffic on secondary roads in residential neighborhoods
  - Inability of present roadway models to accurately predict near-roadway transport of pollutants in anything but ideal conditions
  - Failure of traffic models to reflect accurately actual roadway pollutant emissions
- New data
  - Health impacts
  - Emissions
  - Transport, and
  - Mitigation

Outline of the Talk



- New Information on health impacts of aerosols
  - The role of very fine and ultra fine particles
- New information on vehicular emissions
  - The increasing dominance of spark emission pollutants by mass
  - The higher toxicity of car exhaust
- New information on translation analysis – how dangerous is it to live near roadways?
  - Is mitigation possible?
- Conclusions

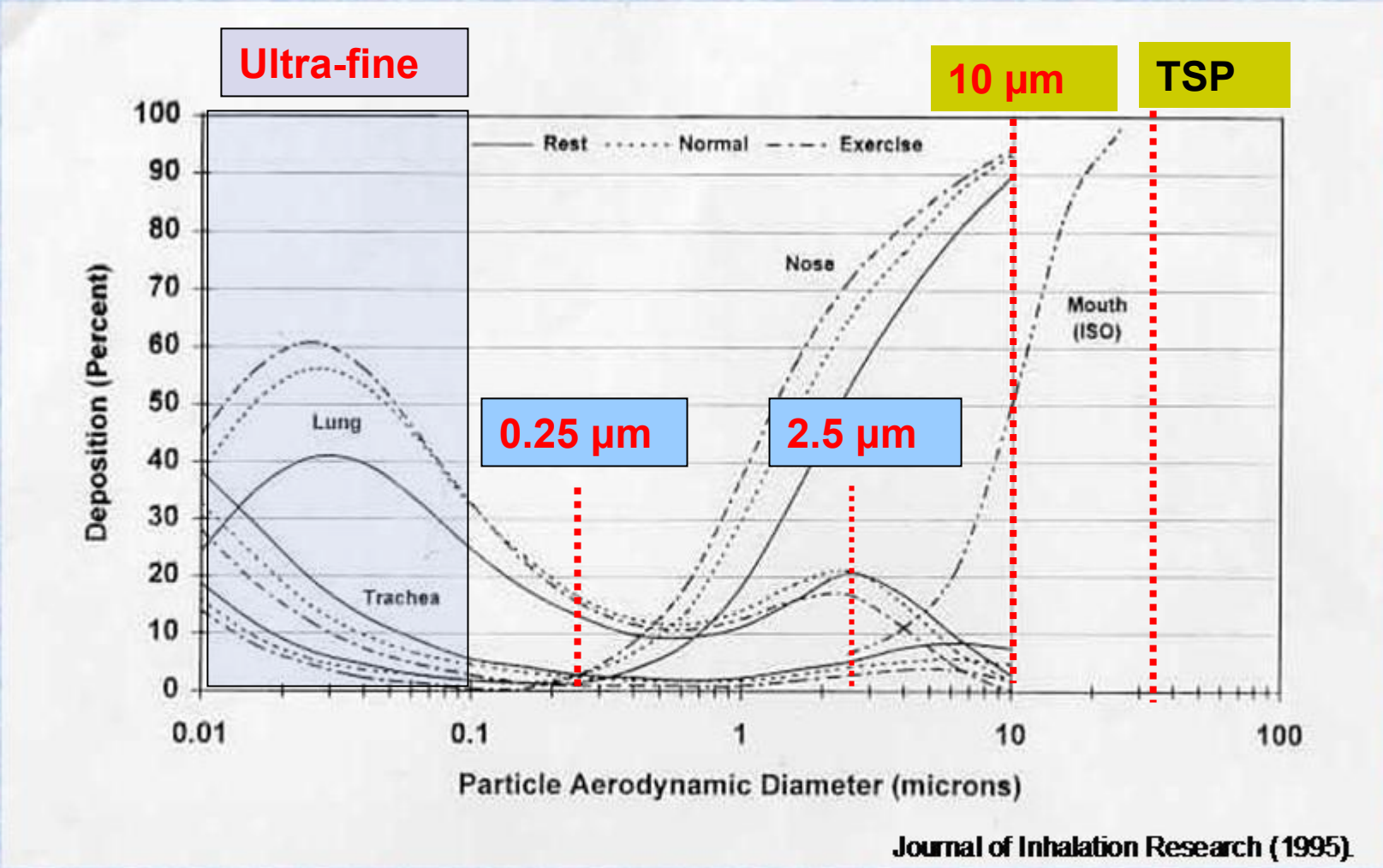
New information on health impacts



- Health data on causal factors for statistically solid particulate impacts (from Devlin, EPA, AAAR, 2003)
  - Coarse re-suspended dust 10 to 2.5 μm (morbidity)
  - Biological aerosols (disease, immune system, asthma, …)
  - Acidic aerosols (lung damage); (caustic aerosols (viz. WTC) – nasal/bronchial scarring)
  - Very fine transition metals (free radicals in the lung)
  - Very fine high temperature organics (PAH carcinogens,…)
  - Ultra fine insoluble species (cardio-vascular impacts)
- Major long term health studies in near-roadway situations (CA CEHS, others)
- California Central Valley (Fresno) ischemic heart disease
- US EPA Particulate Matter Research Centers – 8 M$ @

(5, including UCLA and UC Davis (with USC in last round))

Particle Size versus fraction deposited – mouth, nose, trachea, and lung



This figure shows the relationship between particle size and what percent is deposited in different parts of the respiratory tract.

January 6, 2007

FOUNDED 1857

The Sacramento Bee

FRIDAY, JANUARY 26, 2007 •• www.sacbee.com •• FINAL EDITION 50 CENTS

Senator: Cheney interfered

ew intelligence panel chief
lls of efforts to stall Iraq probe.

ROCK-
LER

enator says
dministra-
domestic
dropping
am is

By Jonathan S. Landay
McCLATCHY WASHINGTON BUREAU

WASHINGTON – Vice President Dick Cheney exerted "constant" pressure on the Republican former chairman of the Senate Intelligence Committee to stall an investigation into the Bush administration's use of flawed intelligence on Iraq, the panel's Democratic chairman charged Thursday.

In an interview with McClatchy Newspapers, Sen. Jay Rockefeller of West Virginia also accused President Bush of running an illegal program by ordering eavesdropping on Americans' international e-mails and

Living near busy roads tied to kids' lung risk

Impact on breathing is long-term health threat, study says

And more ….

Check the distances: < 530 m, <1060 m, 1060 m to 1600 m, > 1600 m

Sacramento Bee/Randall Benton

Findings may affect where houses, roads, schools are built.

By Chris Bowman
BEE STAFF WRITER

Growing up near a freeway stunts a child's breathing capacity for a lifetime, significantly increasing the risk of serious lung and heart diseases later in life, according to researchers who monitored thousands of Southern California children for up to eight years.

The landmark study, led by a team of University of Southern California scientists and released Thursday, delivers a sobering answer to a long-standing question about the health effects of being raised near a busy roadway where air is chronically polluted.

These children not only are more likely to develop asthma, but their lung development can be permanently cut short, increasing their odds of having a heart attack or a life-threatening respiratory condition, starting as early as their 50s.

"It's a big risk factor," said James Gauderman, the author and principal investigator of the study by researchers at USC's Keck School of Medicine.

"If you've got less lung capac-

▶ LUNGS, back page, A16

Lung capacity and proximity to freeways

A new study found substantially underdeveloped lungs among 18-year-olds who were raised near a major roadway, the result of breathing higher levels of tailpipe exhaust. The negative numbers represent the reduced breathing capacity of children living more than a mile away from the heavy traffic. For example, children who lived within one-third of a mile of a freeway during the full eight-year study period exhaled, on average, 98 fewer milliliters of air than those who lived more than a mile from a freeway. Lung capacity is measured by FEV, or forced expiratory volume: how much air a person can exhale during the first second of a forced breath.

Milliliters of air

Freeway distance	*Lung function: Age 10 years	Age 18 years	8-year capacity (cumulative difference)
Within 1/3 mile	-23	-121	-98
Within 2/3 mile	-32	-93	-61
Within 2/3 to one mile	-34	-78	-44

*Average measurements among 1,445 Southern California children who were tested annually for eight years, from age 10 to 18.

Source: University of Southern California

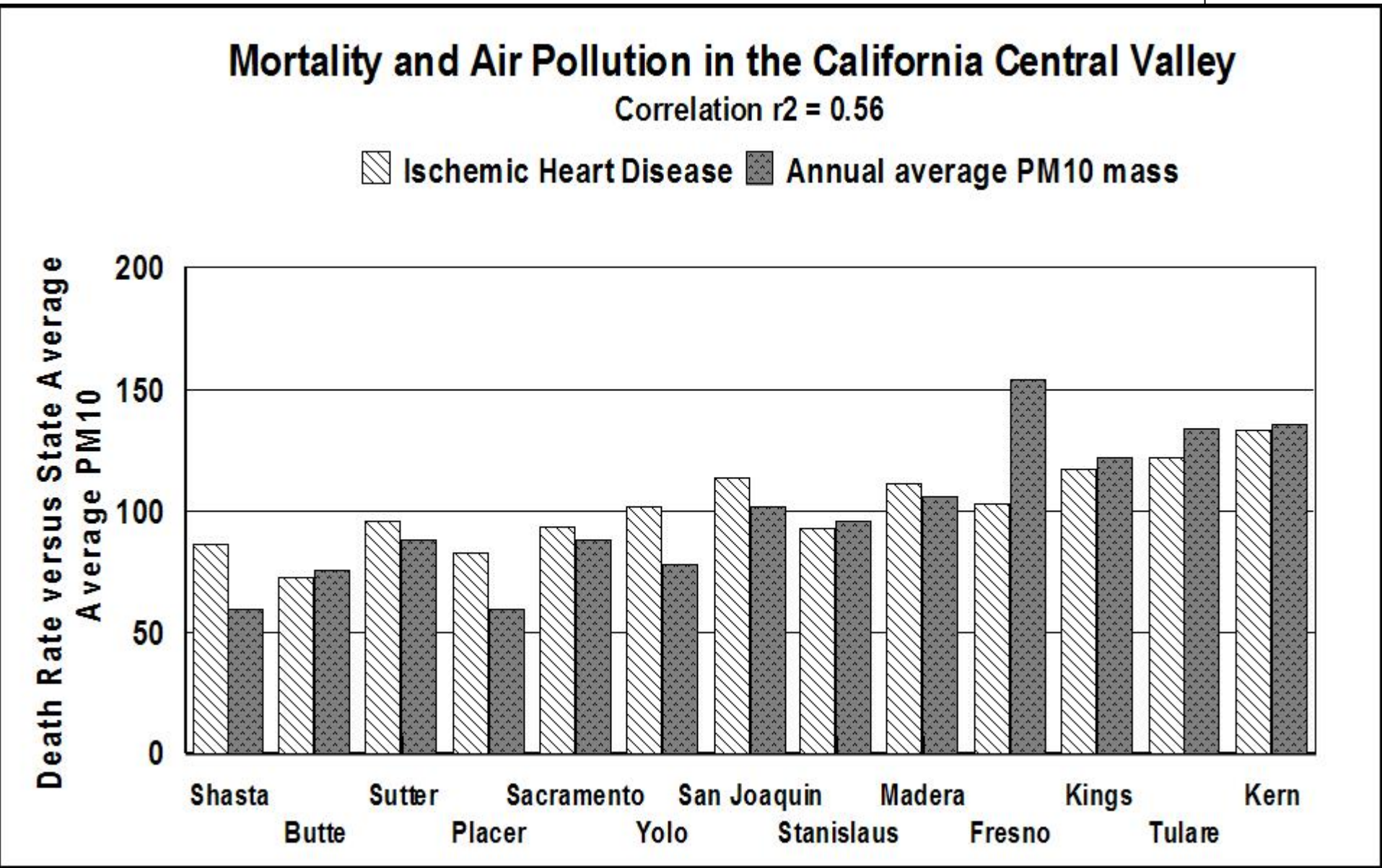
Sacramento Bee

A neighborhood off Garden Highway in South Natomas sits near Interstate 80. Many people in urban areas live close to busy roadways, and a study conducted by USC found diminished lung capacity among youths growing up near such areas.

Aerosols and Ischemia Heart Disease – HETF 1997

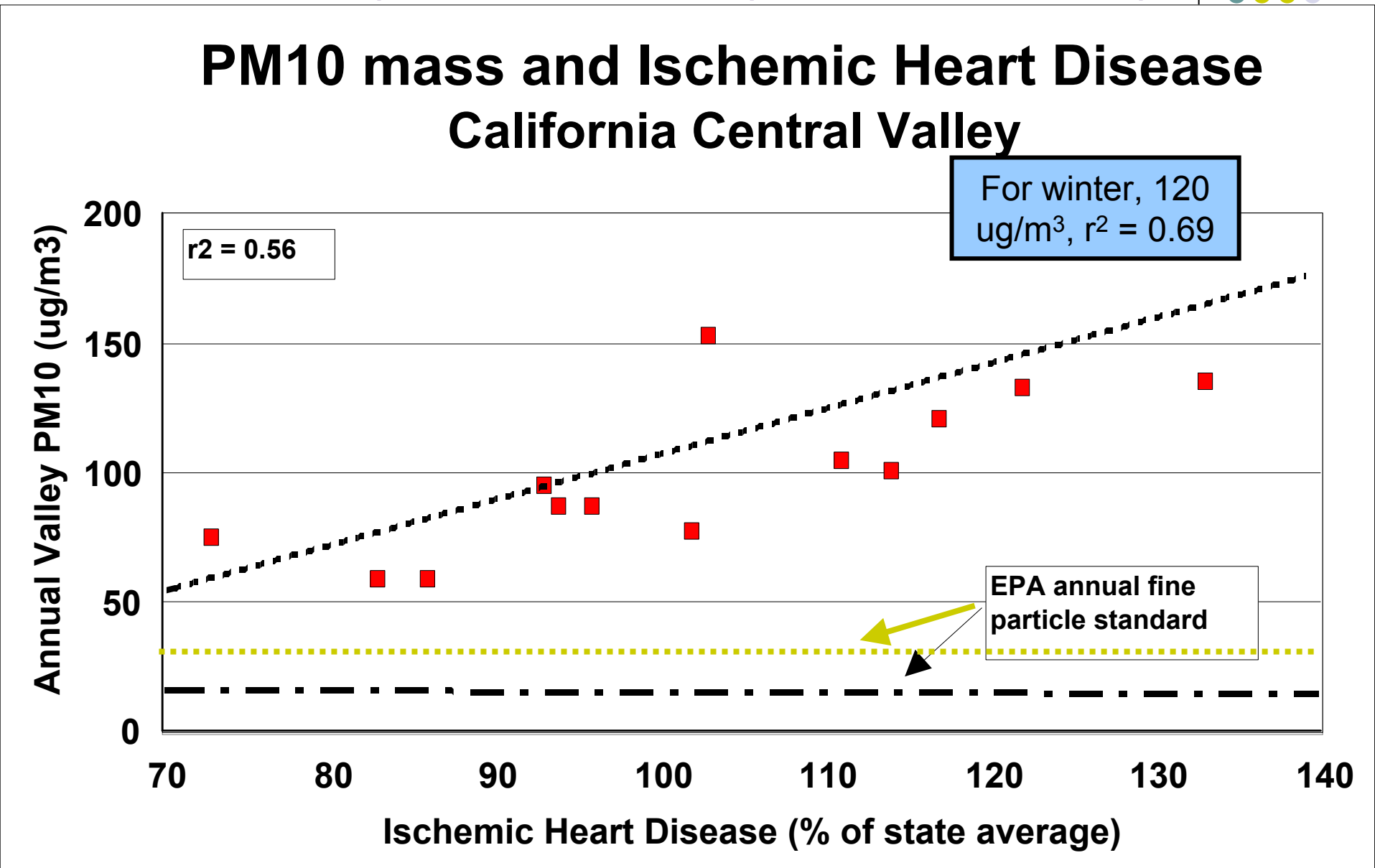
- In 1996, UCSF presented data on stroke and ischemic heart disease, showing a 60% increase in the Central Valley, north to south
- HETF scientists observed the similarities to Central valley pollution
- HETF sponsored ($5K) an analysis of stroke and cardiovascular death rates in the Central valley
- Results in 1997 – now part of EPA Fine Particulate Criterion Document (2005)
- But most of the fine aerosol mass is highly hydrated ammonium nitrate and essentially harmless!

Results of the HETF BCSET Central Valley Report (1997)

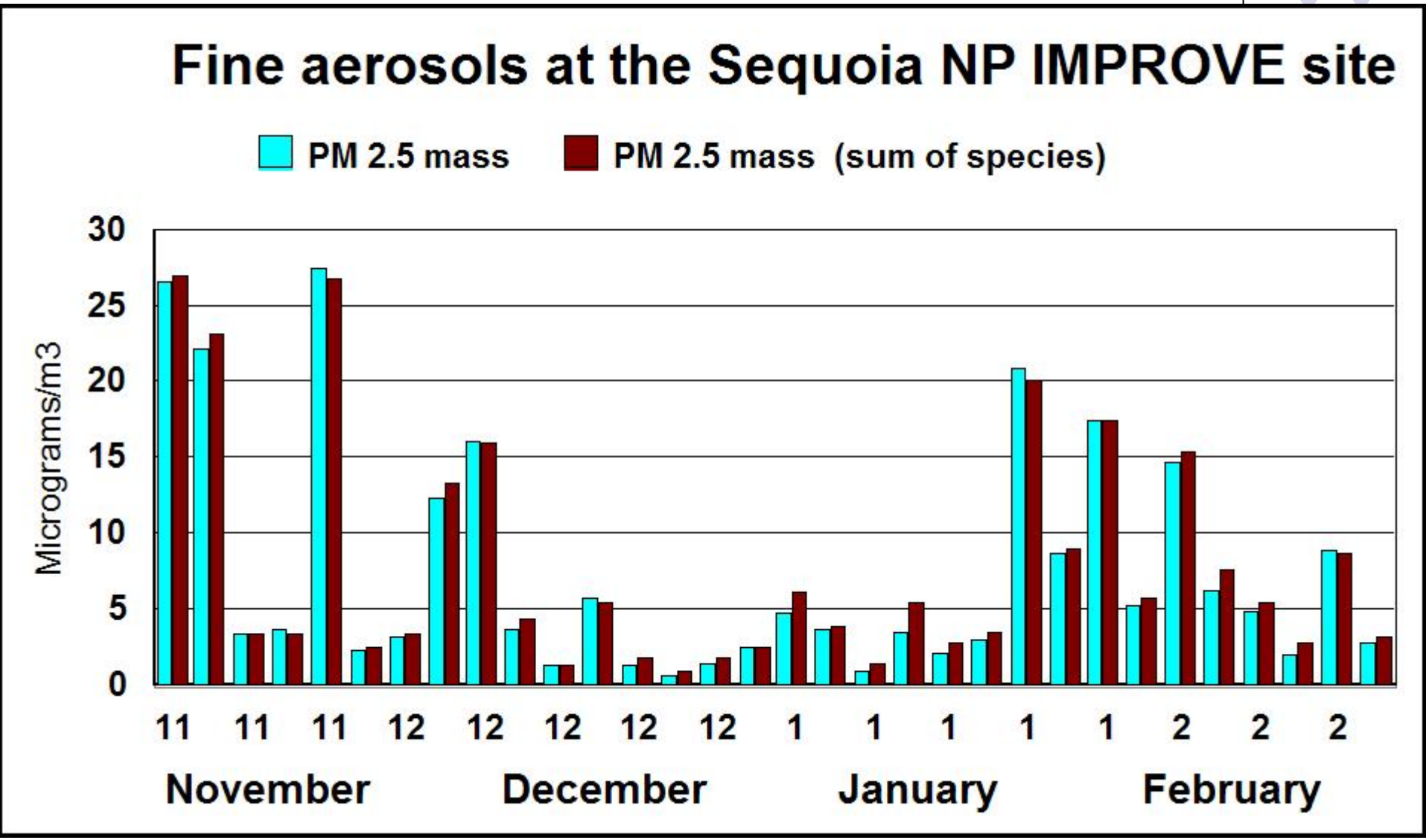


Health Impacts of Valley Aerosols:

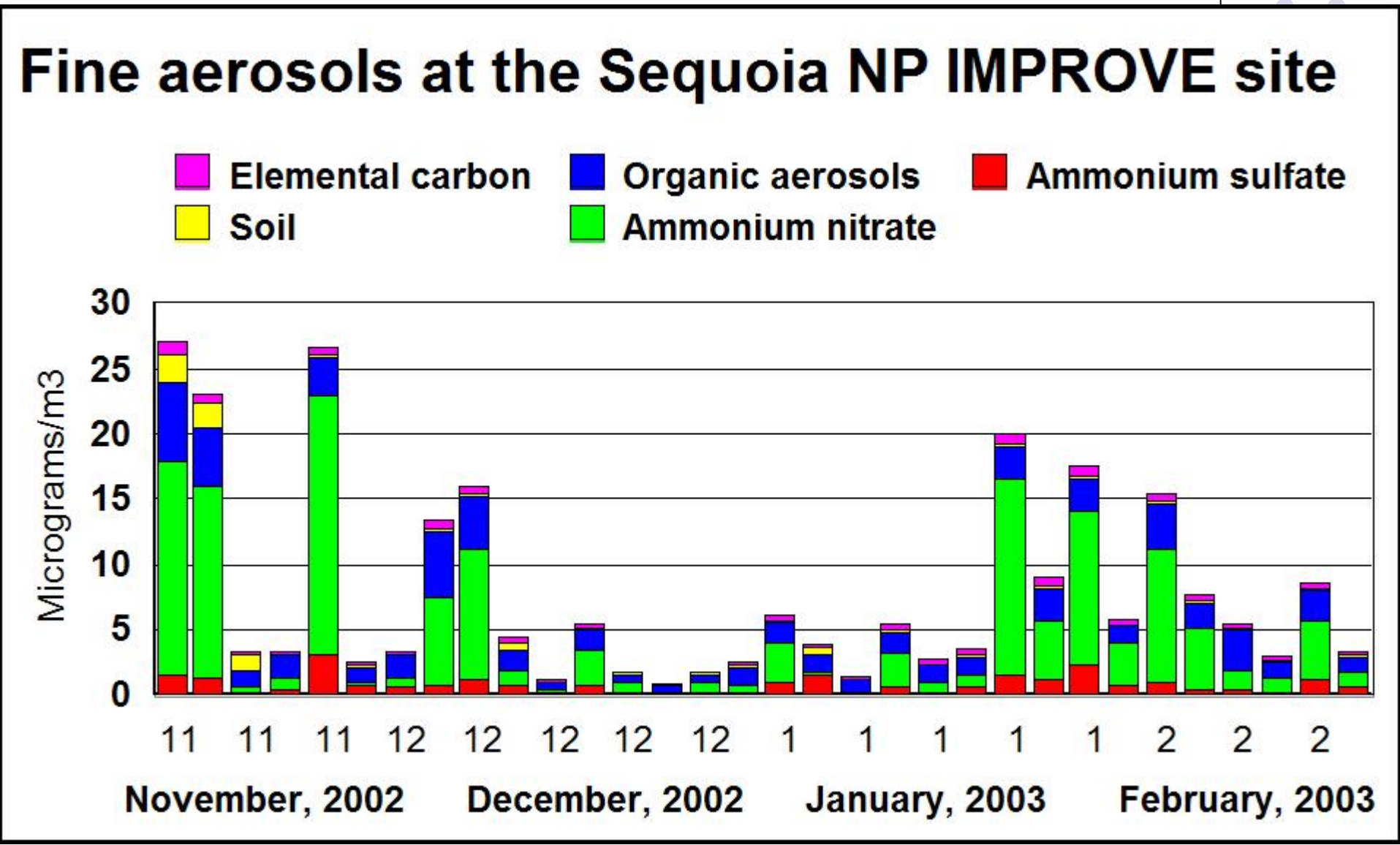
Note - CO, no impact, ozone, little impact; strokes – no impact



The IMPROVE site gets winter valley aerosols on occasion…



The IMPROVE site in winter is mostly $(NH_4)NO_3$, + wood smoke - diesels/cars



Clueless in California and/or USA…

$PM_{2.5}$ mass attributions

- Models give inconsistent results – example of Los Angeles -
  - US EPA MOBILE 2/3 diesel, 1/3 cars
  - CA ARB EMFAC 2007 1/3 diesel, 2/3 cars
- Most winter $PM_{2.5}$ in Fresno is harmless, but something in the $PM_{2.5}$ is lethal!
- The Chemical mass balance at Fresno
  - $PM_{2.5}$ EPA Chemical Mass Balance (CMB) organics largely (> 85 %) wood smoke
  - $PM_{2.5}$ “organics” actually 75% car and diesel, 15% wood smoke, and 10% mis-labeled fine soil (12/2001).
- Yet the local air pollution control district is intent on lowering the wood smoke component.

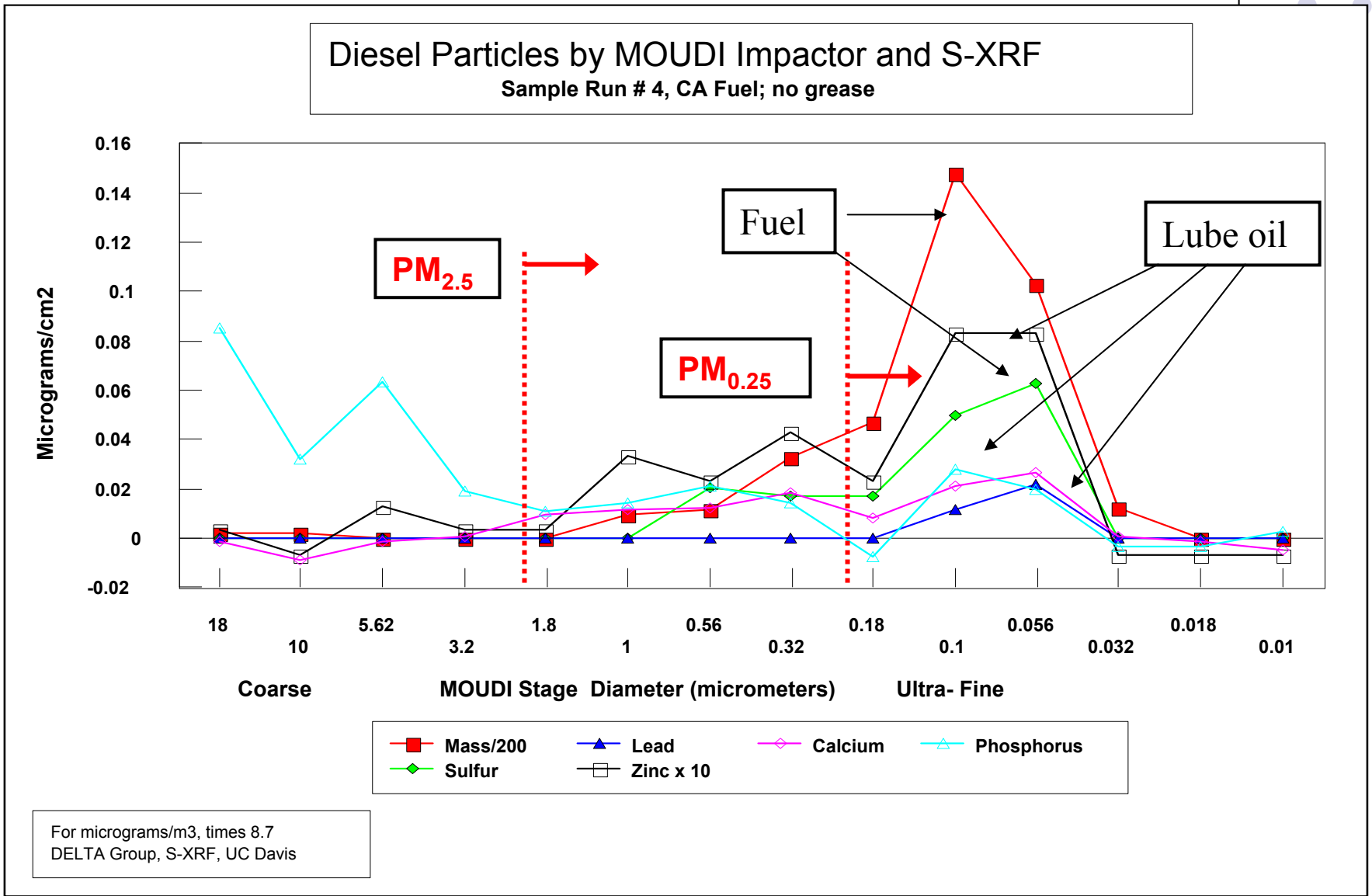
Summary of Health Impacts of aerosols

- Short term (few hour) triggering of asthmatic attacks
- Lung damage seen in children in a few years of near highway exposure
- Increased (60%) mortality in the elderly from cardio-vascular damage
- However, we don't know which are the most important roadway derived factors for morbidity and mortality
  - Statistical and laboratory studies suggest ….
    - Morbidity – $PM_{10-2.5}$
    - Mortality – $PM_{2.5}$, and most likely < $PM_{0.25}$, < $PM_{0.1}$, toxics, and ultra fine particle numbers

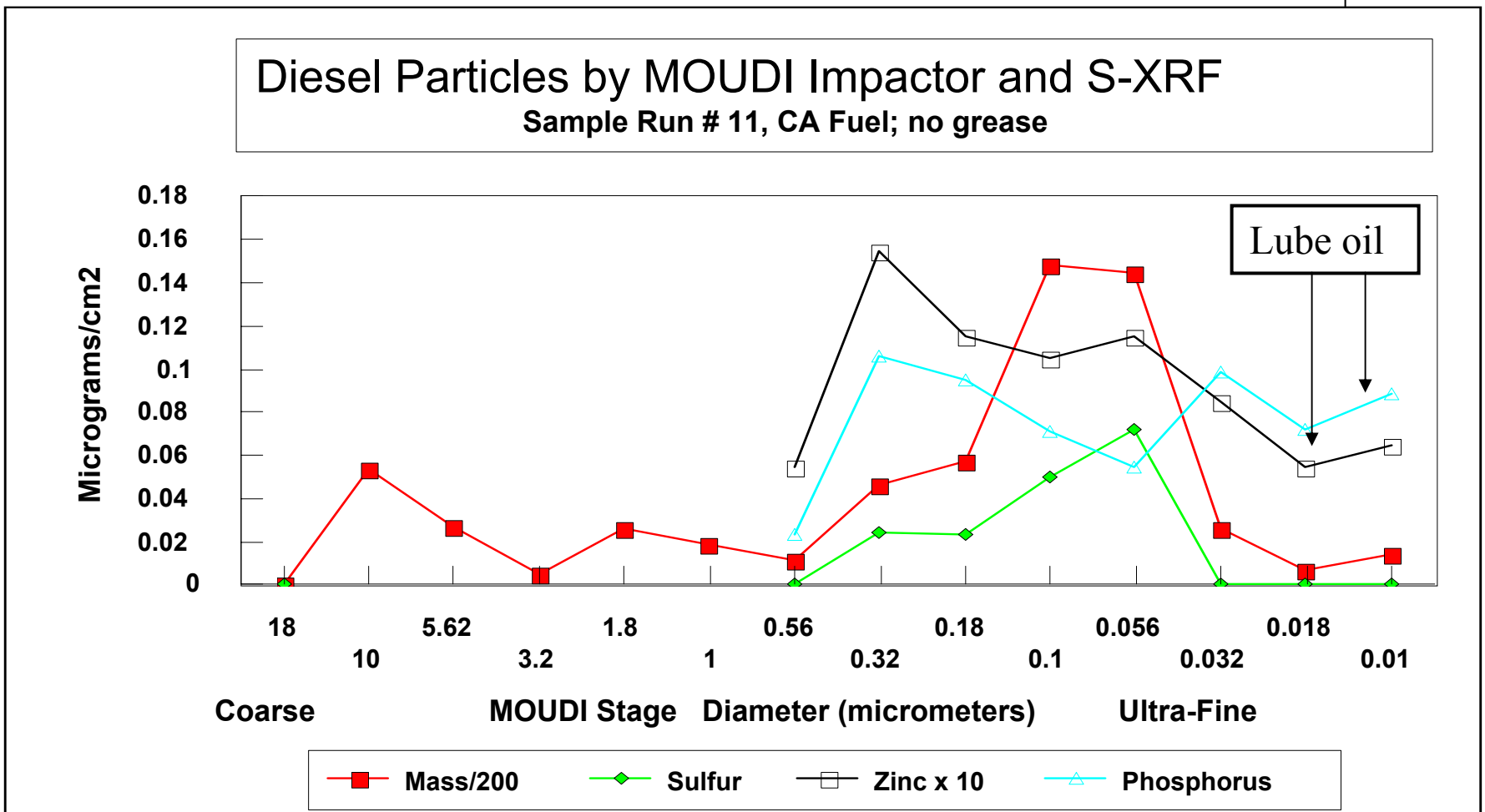
New information – vehicular emissions

- Size and composition of diesel aerosols, including ultra fines (U. Minn./DRI/UC Davis)
- Roadway studies of diesel and auto emission rates
  - California CERC and Nevada DRI laboratory data
  - HEI Tuscarora PA tunnel study freeway studies
  - CA Air Resources Board studies of freeway ultra fines
  - Breathe California (ex- Amer. Lung Assoc) studies of secondary roadways in Sacramento
- Toxicity of used diesel and spark emission vehicle
  - Lubricating oils - Nevada Desert Research Inst.
  - EPA Region IX/ASU/UC Davis organics, trucks, trains, and cars (embargoed – meeting on June 14)

U. Minn. Dynamometer Diesel tests; DRI mass and sulfates, DELTA Group S and elements

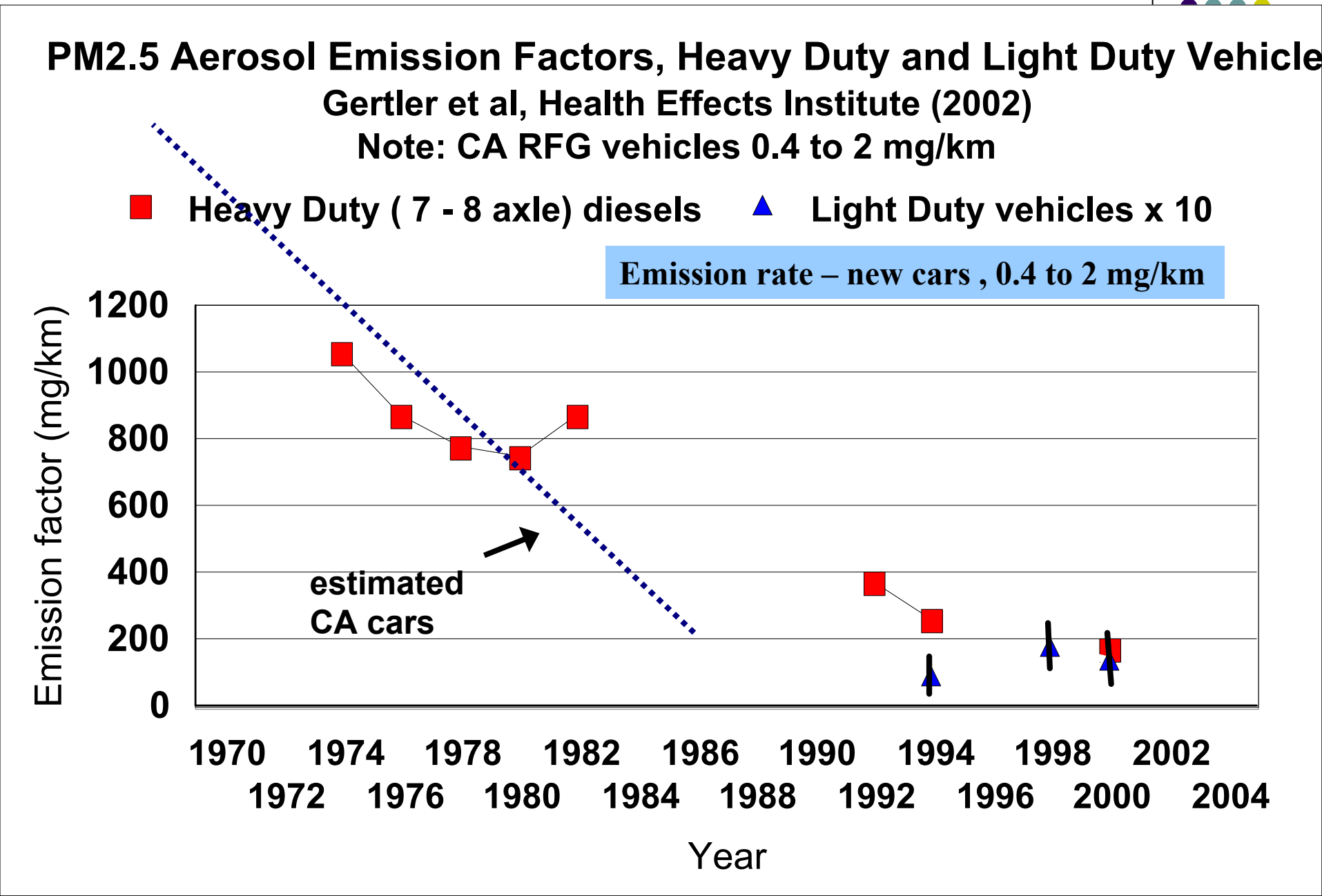


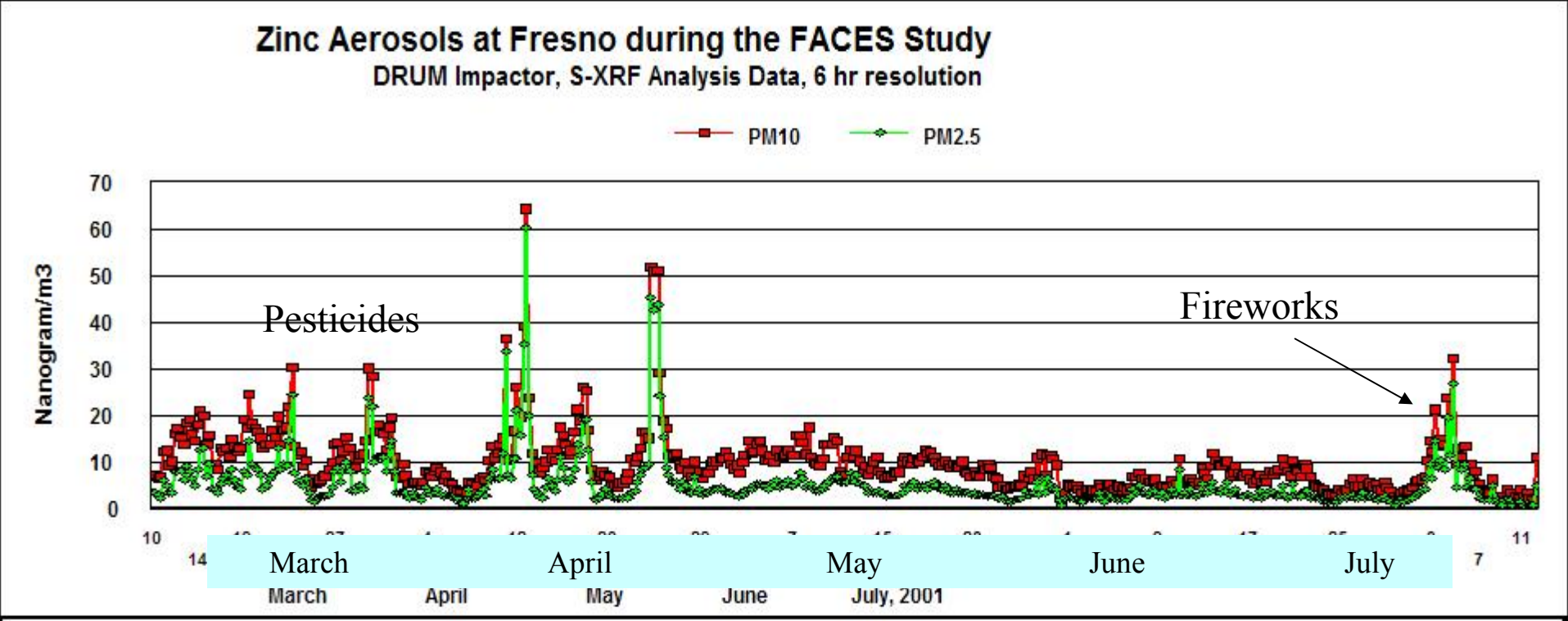
U. Minnesota Dynamometer Diesel Tests; same California fuel, different engine – no mention of smoke

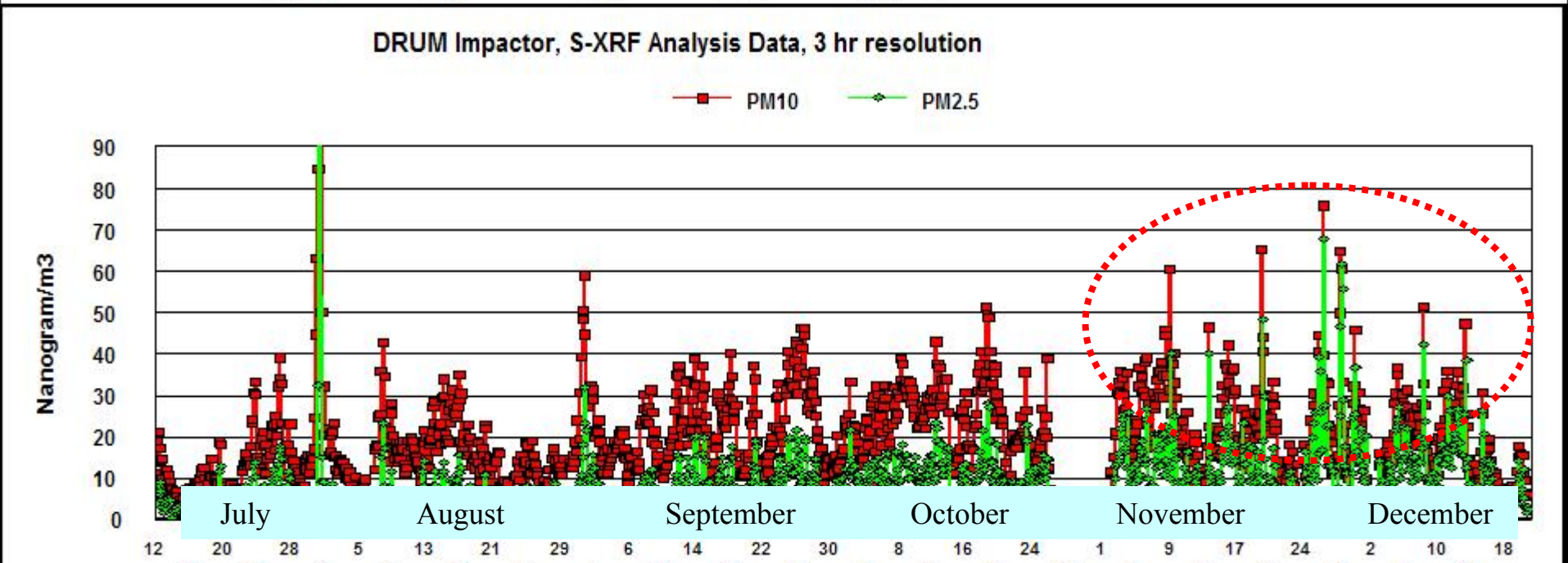


For micrograms/m3, times 8.7
DELTA Group, S-XRF, UC Davis

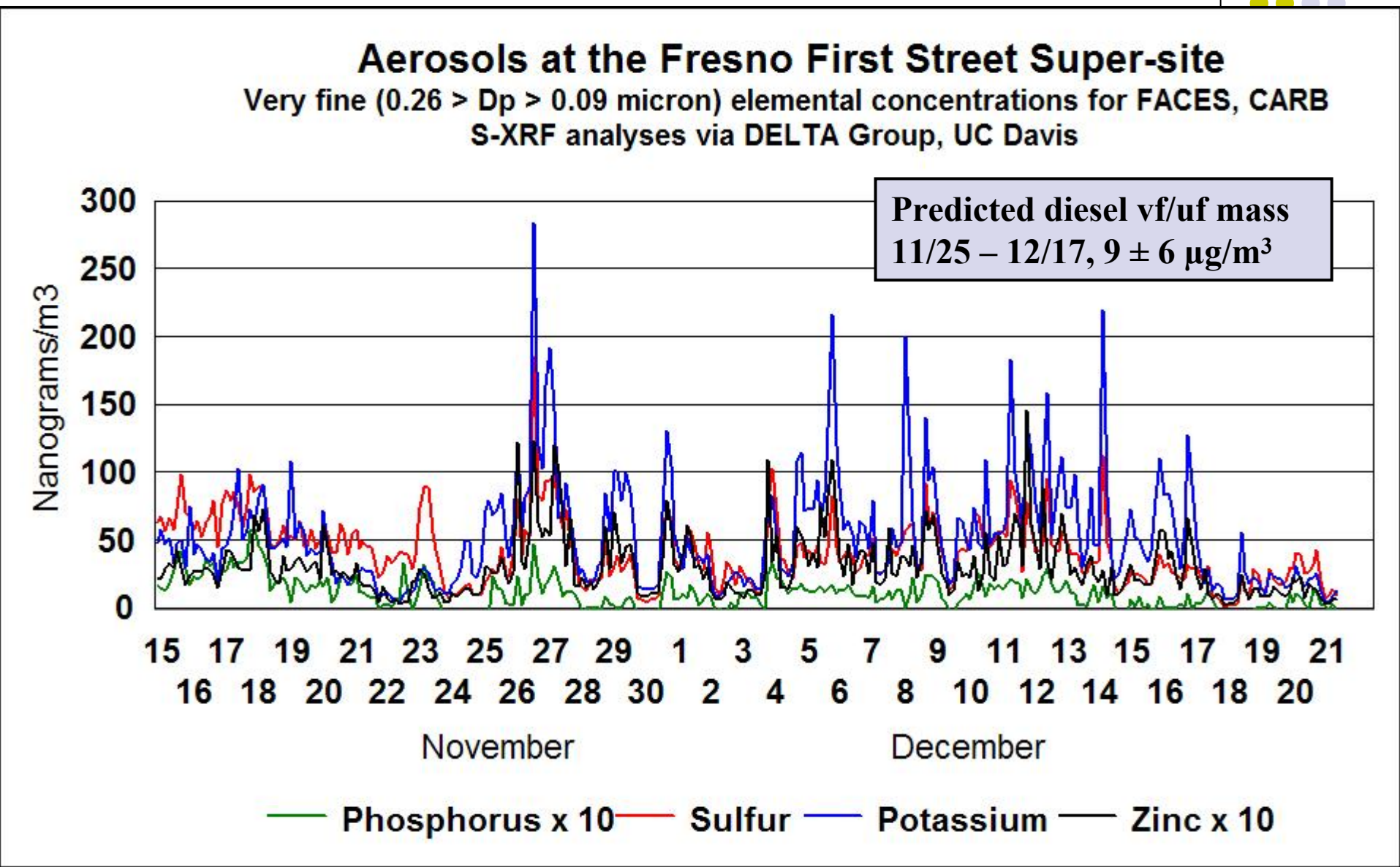
Average Zn to mass, all DRI tests, 1800 ± 1300


PM2.5 Aerosol Emission Factors, Heavy Duty and Light Duty Vehicle
Gertler et al, Health Effects Institute (2002)
Note: CA RFG vehicles 0.4 to 2 mg/km
Heavy Duty (7 - 8 axle) diesels
Light Duty vehicles x 10
Emission rate – new cars , 0.4 to 2 mg/km
Emission factor (mg/km)
1200
1000
800
600
400
200
0
estimated
CA cars
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
Year


Zinc Aerosols at Fresno during the FACES Study
DRUM Impactor, S-XRF Analysis Data, 6 hr resolution
PM10
PM2.5
Nanogram/m3
70
60
50
40
30
20
10
0
Pesticides
Fireworks
March
April
May
June
July
March
April
May
June
July, 2001


DRUM Impactor, S-XRF Analysis Data, 3 hr resolution
PM10
PM2.5
Nanogram/m3
90
80
70
60
50
40
30
20
10
0
July
August
September
October
November
December

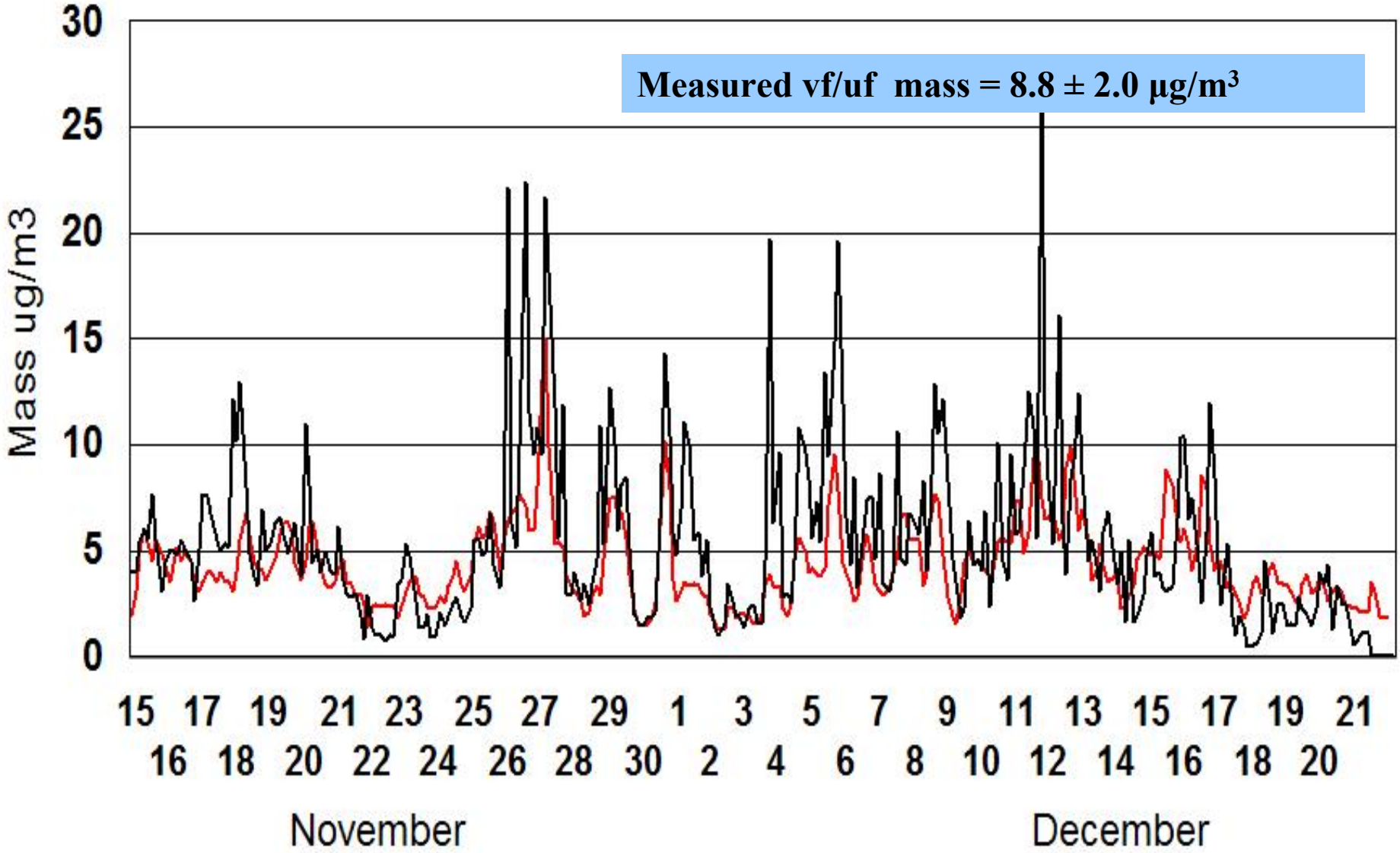
Very fine aerosols characteristic of diesels/ smoking cars in Fresno ~ 1 km from freeways



Very fine (0.26 > Dp > 0.09) Aerosols at Fresno, CA

Supersite, First Street, > 1 km from nearest freeway

Mass measured — Mass predicted based on U. Minn. diesels, CA fuel



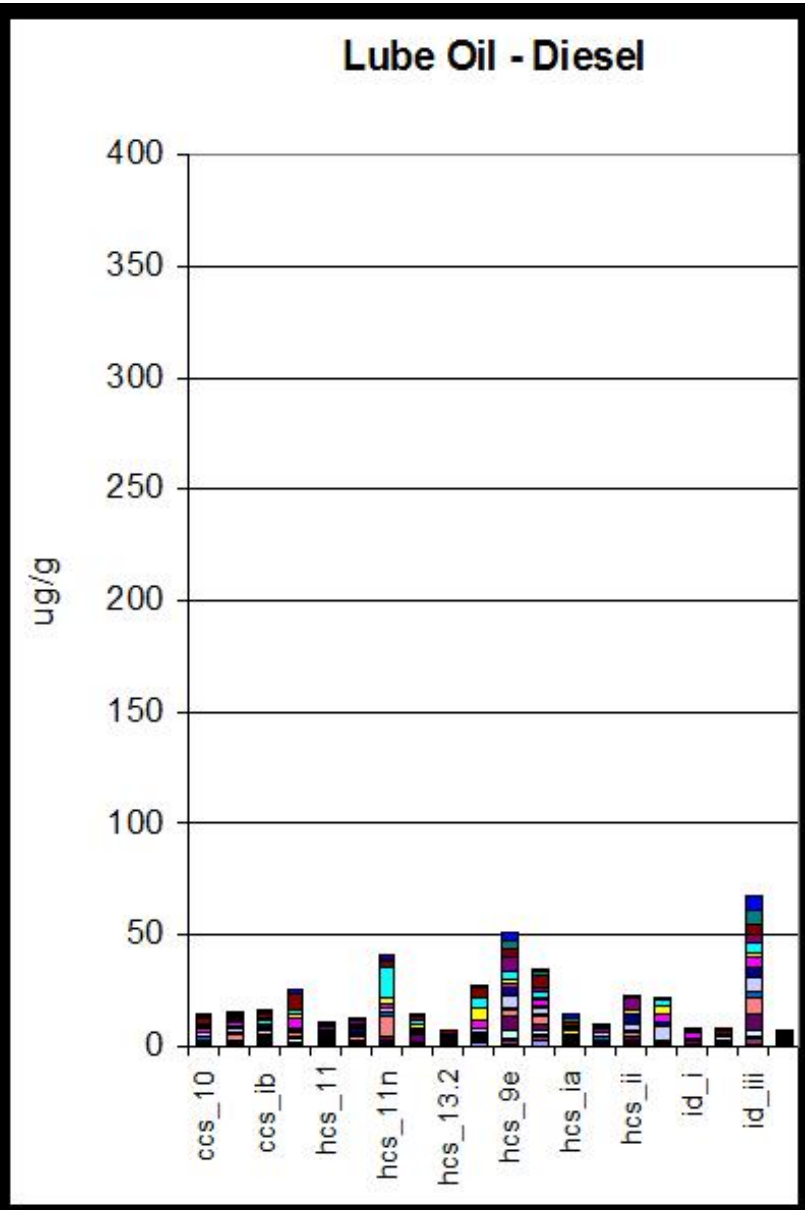
Ischemic heart disease death rate?

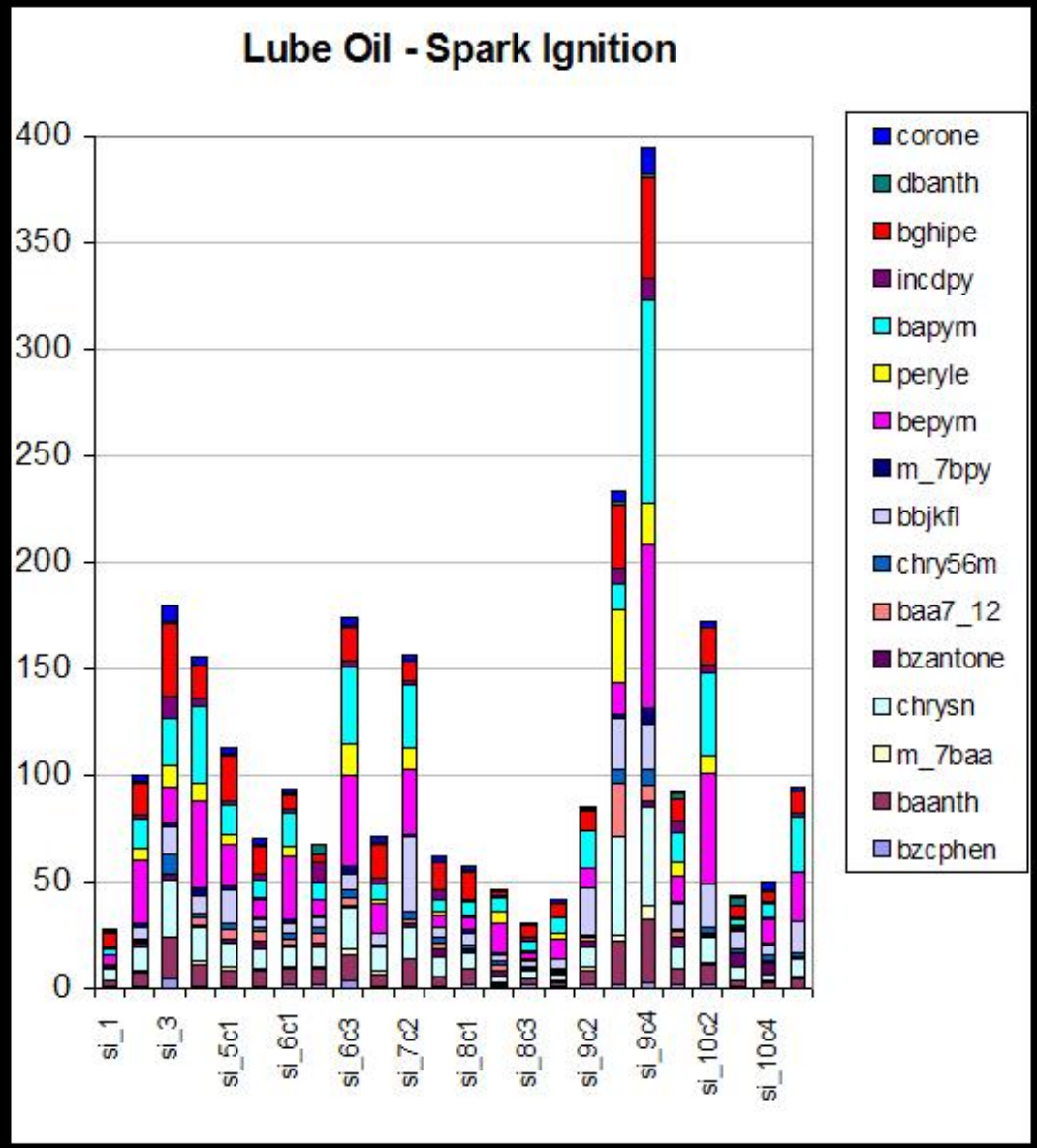
- Massive 60% impact on the largest total death rate in the California Central Valley
- Health impacts have been continuous since at least 1989, when the first analyses were made, totaling by now thousands of documented fatalities.
- Everything we know about vehicle exhaust makes it the overwhelming choice for the observed ischemic heart disease death rate in the Central Valley of California.

New information on the toxicity of car exhaust

- There is evidence that spark emission car exhaust is more toxic than diesel truck/bus exhaust
  - Theory of PAH formation makes small cylinder vehicles worse than large cylinder vehicles
    - Temperature of formation for PAHs is low, < 600 C
    - Higher cylinder wall to volume ratio, cars vs trucks
  - Gertler at al 2002 had the benzo-a-pyrene emission rates roughly the same per vehicle, cars vs trucks, for the HEI Tuscarora Tunnel Study
  - We find relatively high ultra fine mass from the lubricating oil in CNG busses, ~ ¼ diesel busses
  - Eric Fujita at Desert Research Institute showed used spark emission lubrication oil was 10 to 20 times higher in PAHs than used diesel oil

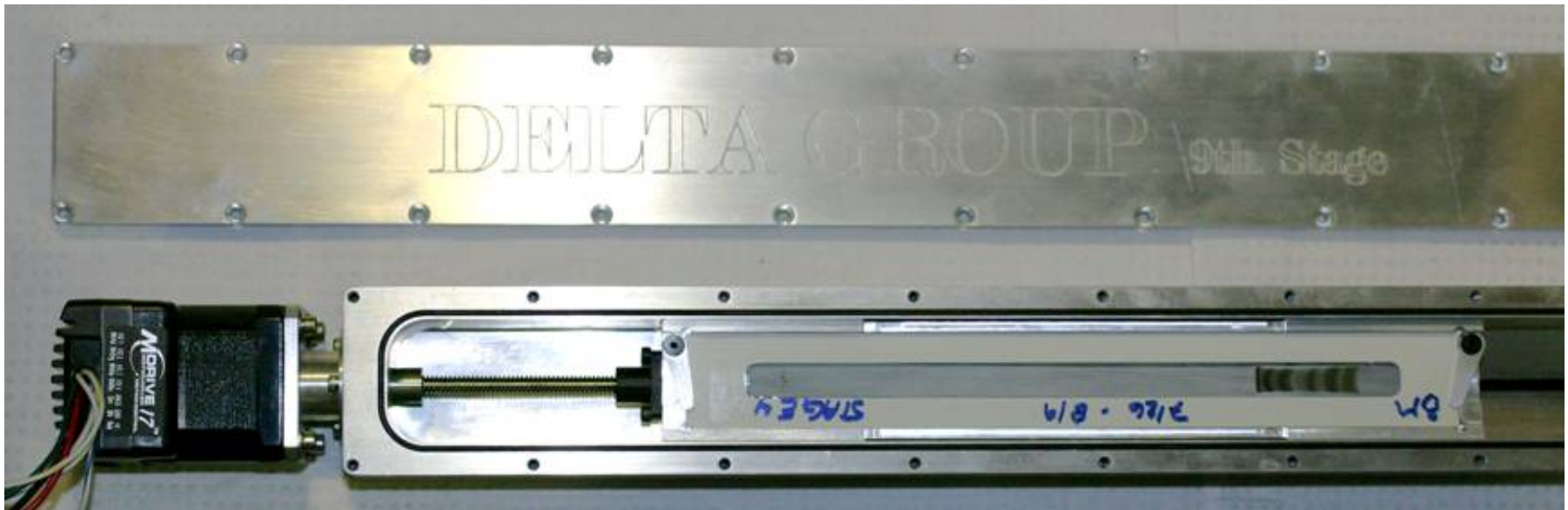
Cars have more PAHs in their oil than diesels

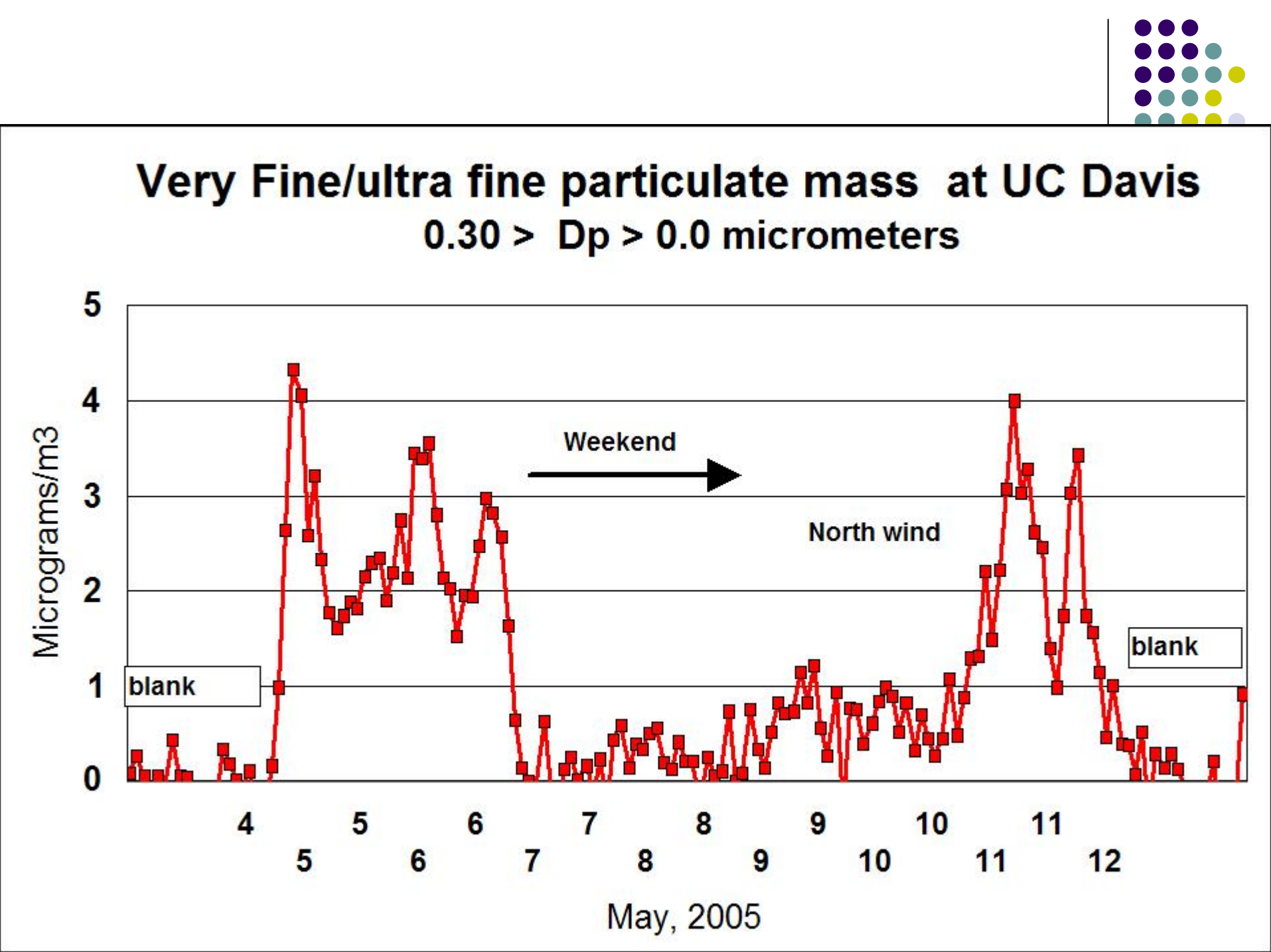




UC Davis DELTA Group Continuous Ultra-fine "Streaker" Sampler

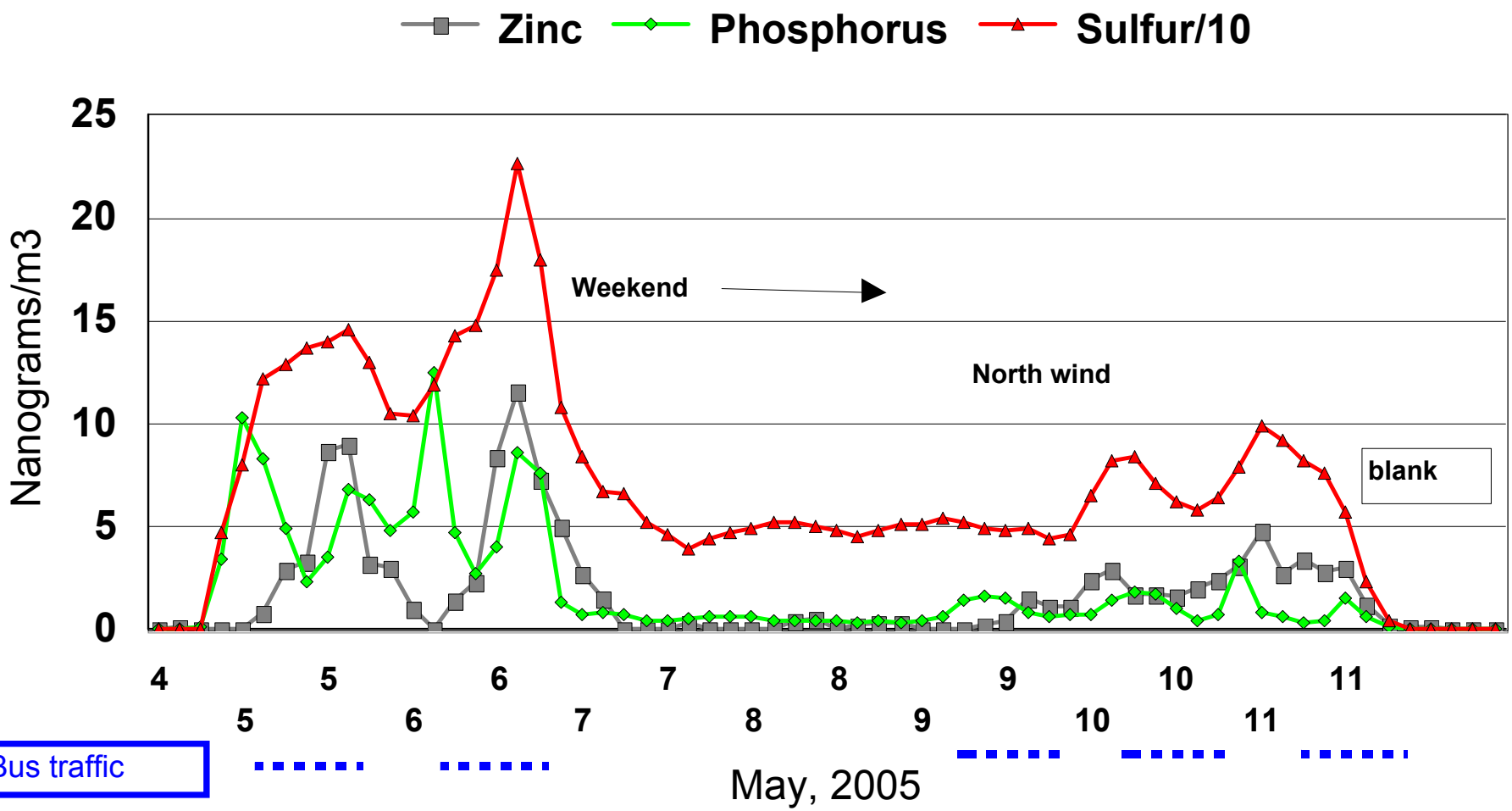
- Mass < 0.09 μm by soft beta ray
- Elements sodium through zirconium, plus lead, by S-XRF to 0.020 ng/m^3
- Time resolution typically 3 hr




Very Fine/ultra fine particulate mass at UC Davis
0.30 > Dp > 0.0 micrometers
Micrograms/m3
5
4
3
2
1
0
Weekend
North wind
blank
blank
4
5
6
7
8
9
10
11
5
6
7
8
9
10
11
12
May, 2005

Very Fine/Ultra Fine (Dp < 0.3 micron) Aerosols, Davis, CA

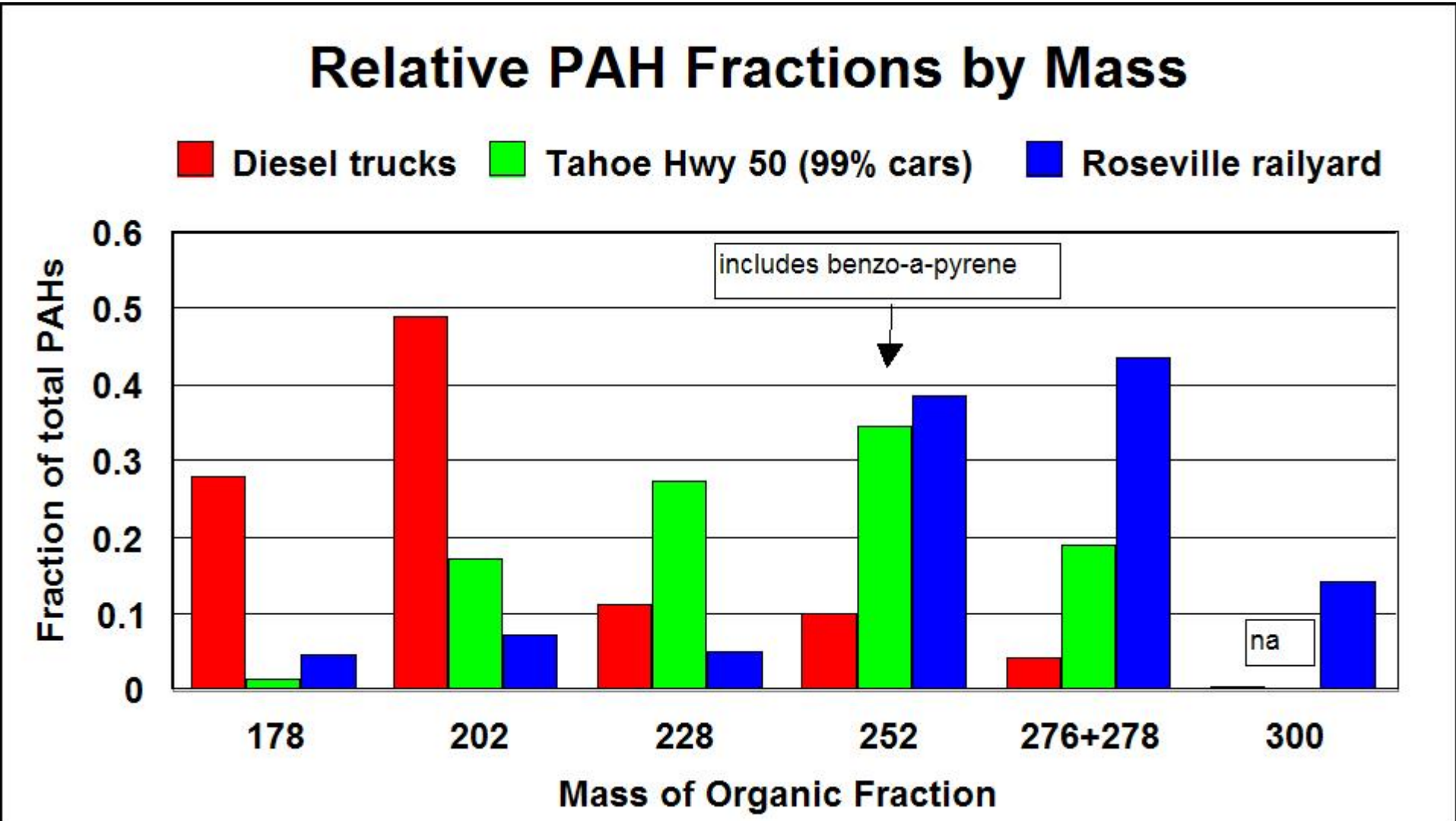
Collection by "streaker" filter, mass analysis by soft beta transmision



Typical daytime traffic 50 m south of sampling site: CNG still 4 x better than diesel

Toxicity of cars? (preliminary-embargoed)

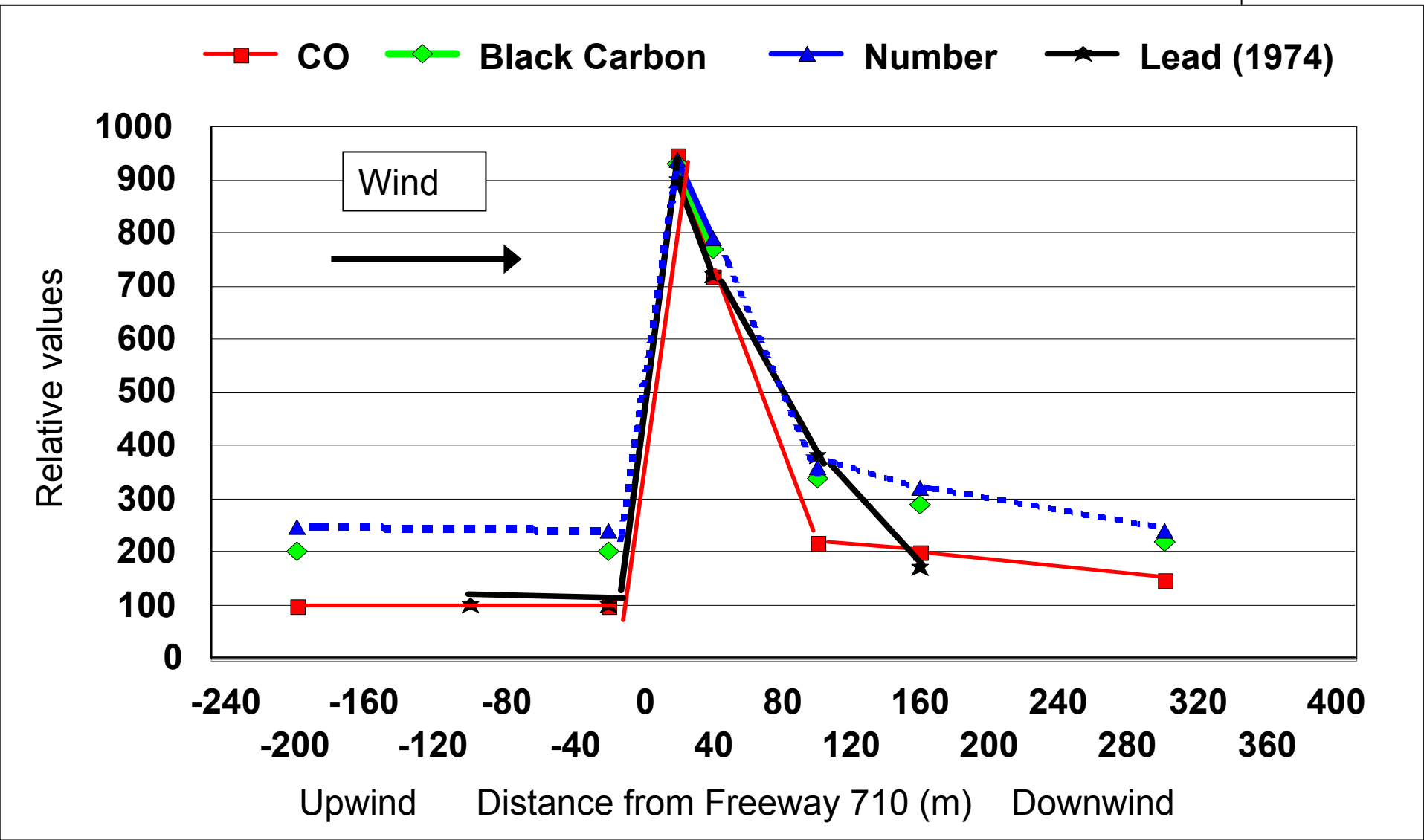
About the same benzo-a-pyrene PAHs as diesel trucks and busses per vehicle!

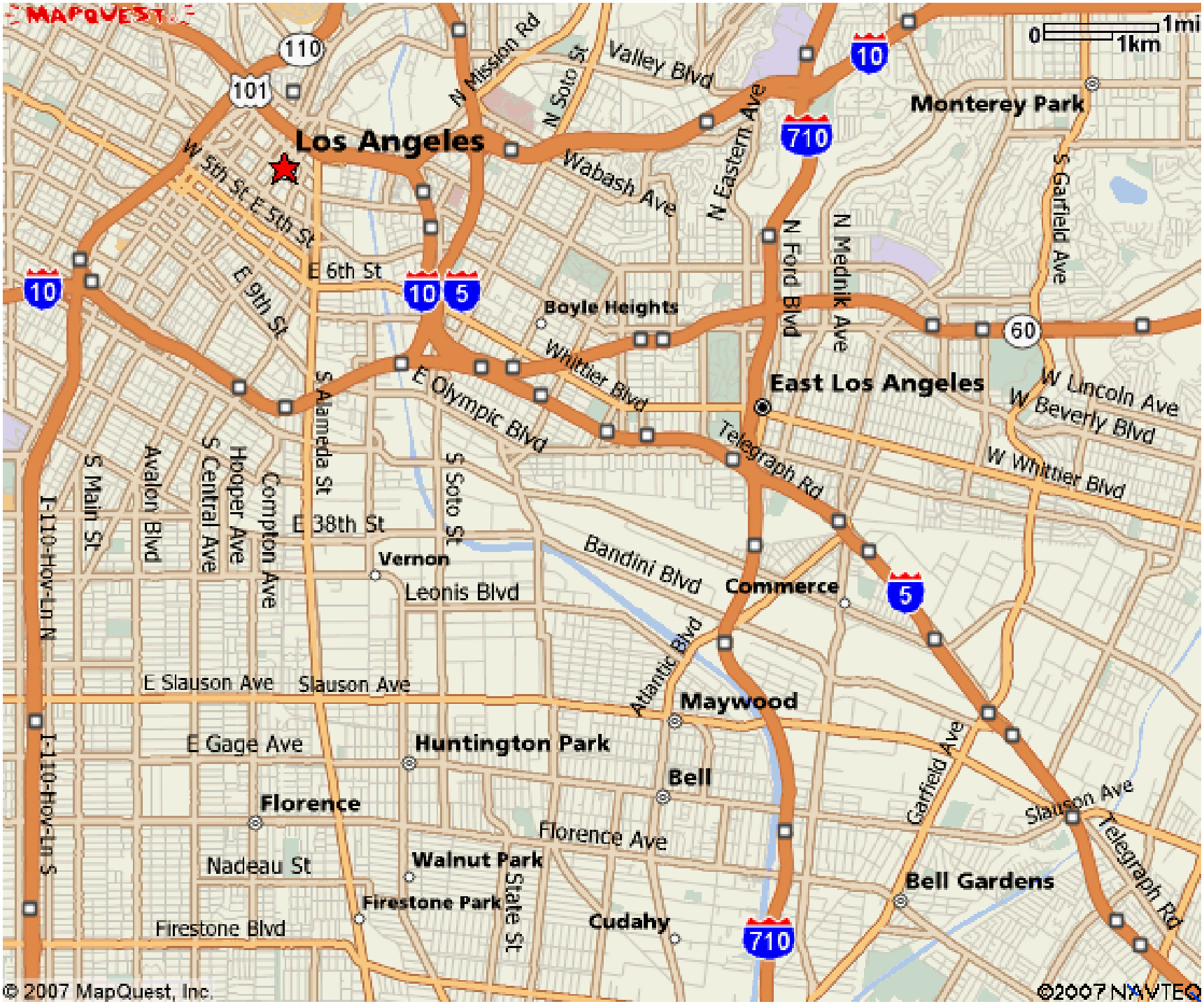


New information on translation analysis – how dangerous is it to live near roadways?

- Original US EPA analyses: Source enriched, a single mobile van close downwind
- Line source diffusion – Pasquill stability plus settling velocity 1974
- CalLine Models I through IV
- EMFAC Models latest Nov, 2007
- New UC Davis model with terrain (under development) - Monte Carlo Models?

Lateral transport of ultra fine particles – efficient transport, no coagulation!




MAPQUEST
0
1mi
1km
Los Angeles
Monterey Park
East Los Angeles
Boyle Heights
Vernon
Commerce
Maywood
Huntington Park
Bell
Florence
Walnut Park
Firestone Park
Cudahy
Bell Gardens
Leonis Blvd
Bandini Blvd
Florence Ave
Slauson Ave
E Slauson Ave
E Gage Ave
Nadeau St
Firestone Blvd
E 6th St
E 9th St
E 38th St
W 5th St
E 5th St
Wabash Ave
Valley Blvd
N Mission Rd
N Soto St
N Eastern Ave
N Ford Blvd
N Mednik Ave
S Garfield Ave
Whittier Blvd
E Olympic Blvd
W Lincoln Ave
W Beverly Blvd
W Whittier Blvd
Telegraph Rd
S Alameda St
S Soto St
S Main St
Avalon Blvd
S Central Ave
Hooper Ave
Compton Ave
I-110-Hov-Ln N
I-110-Hov-Ln S
Atlantic Blvd
Garfield Ave
State St
10
101
110
710
5
60
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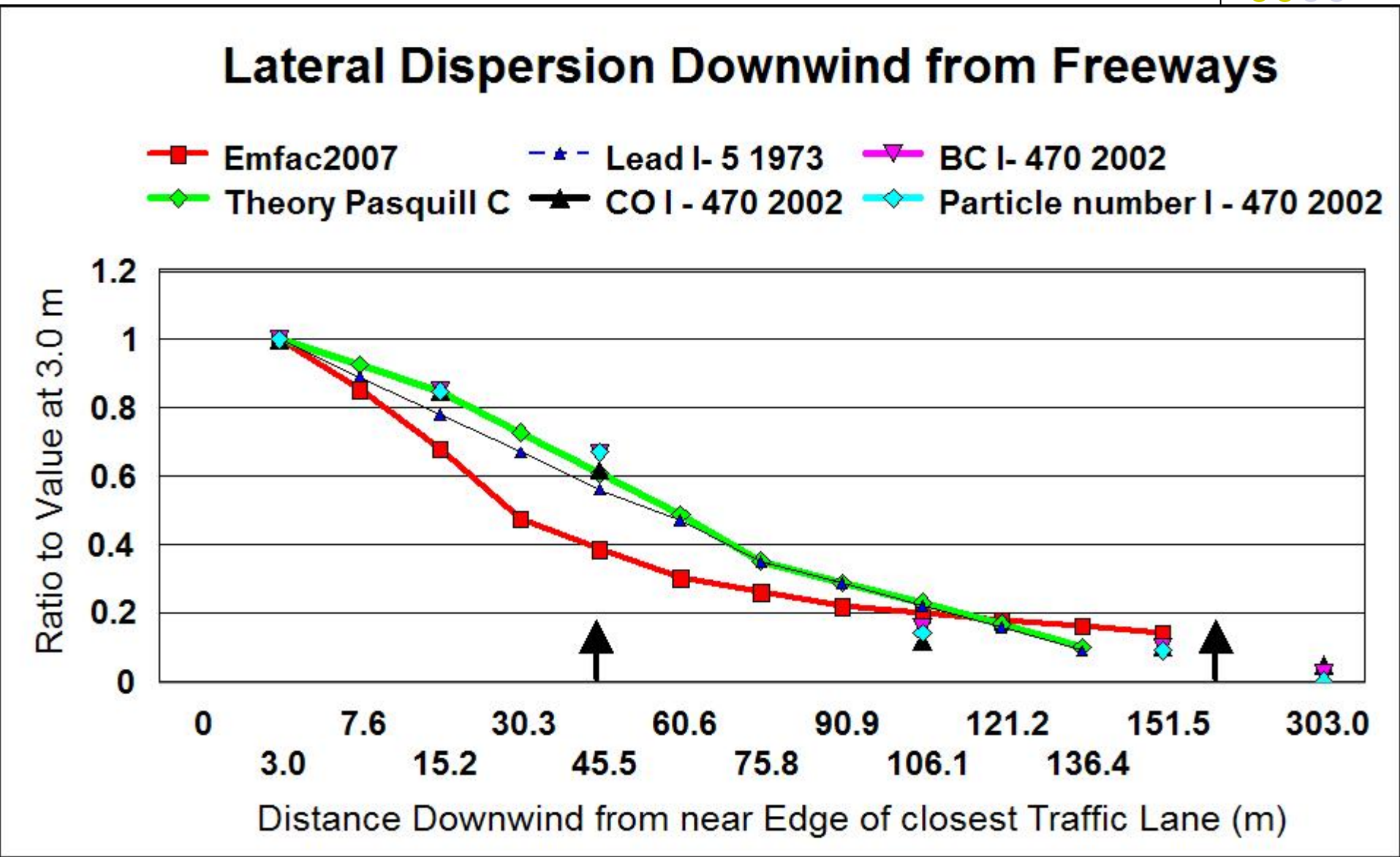
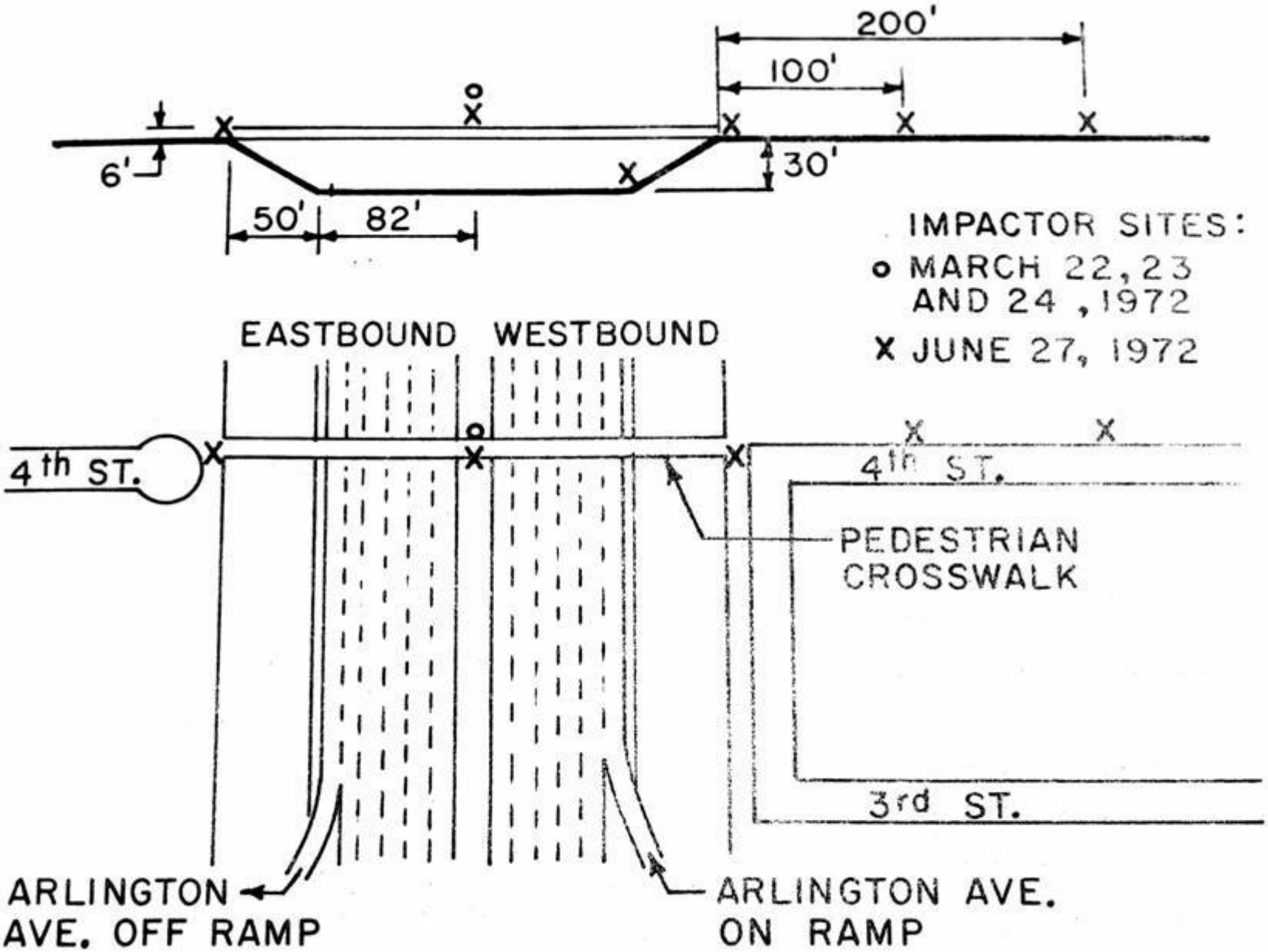
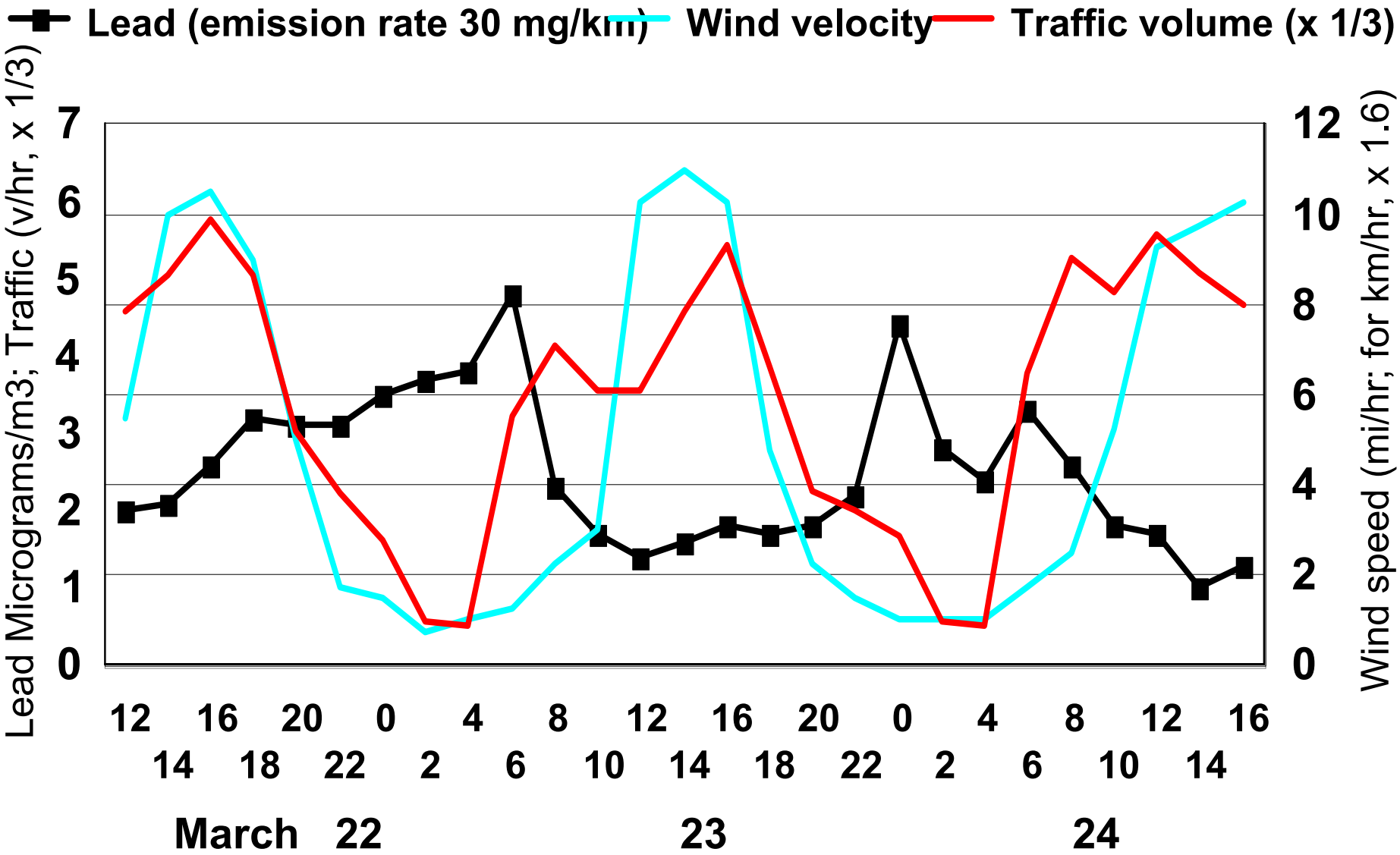
Lateral transport at grade



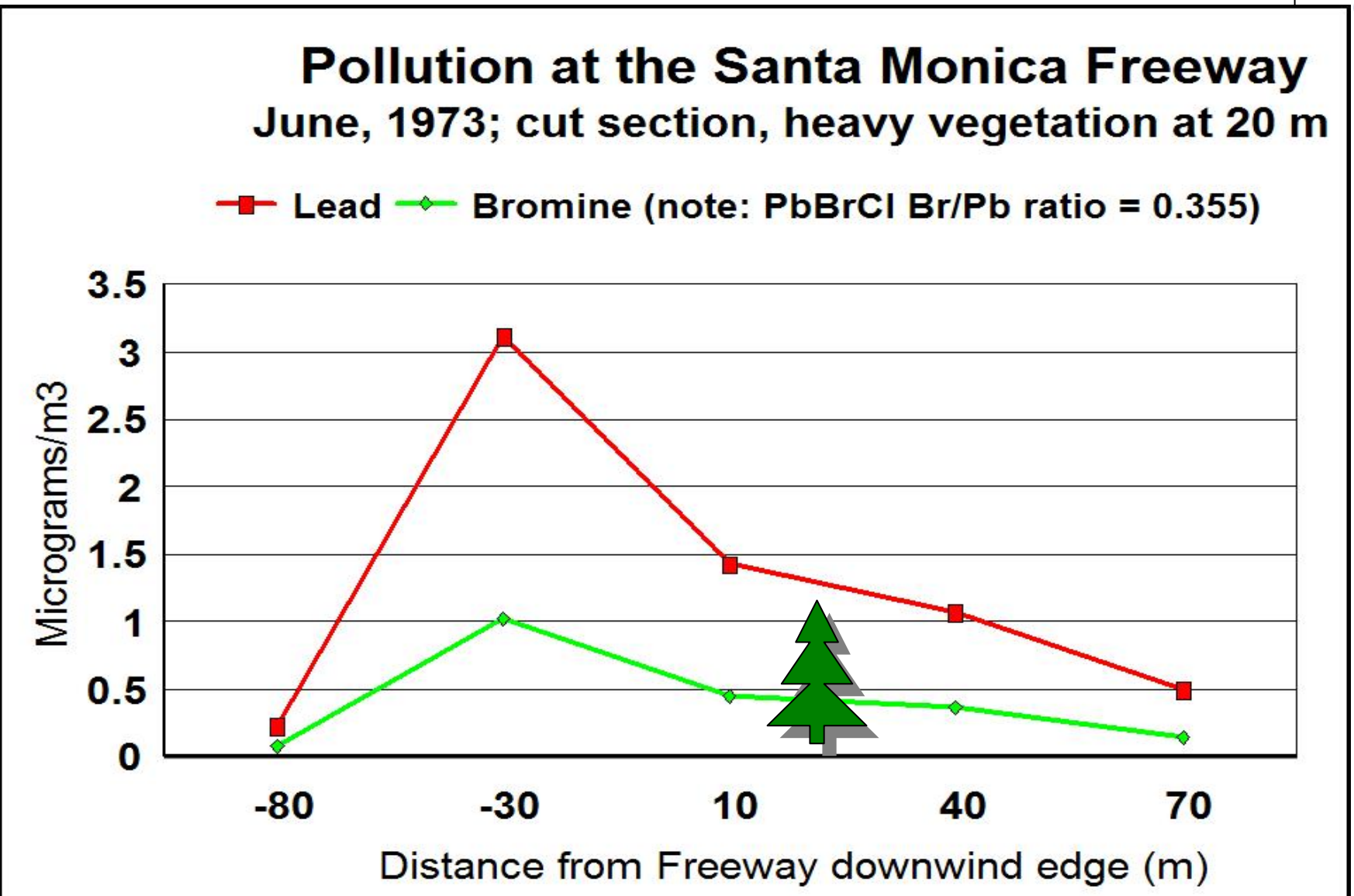

200'
100'
6'
30'
50'
82'
IMPACTOR SITES:
o MARCH 22, 23 AND 24, 1972
X JUNE 27, 1972
EASTBOUND
WESTBOUND
4th ST.
4th ST.
PEDESTRIAN CROSSWALK
3rd ST.
ARLINGTON AVE. OFF RAMP
ARLINGTON AVE. ON RAMP

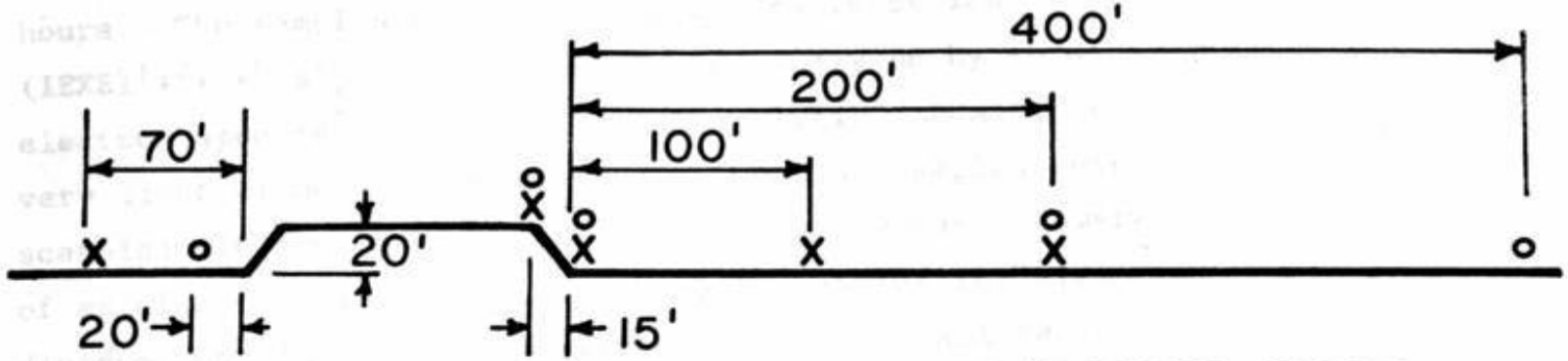
Pollution of the Santa Monica Freeway

Los Angeles, CA 1973; average total daily traffic 233,000 v/day

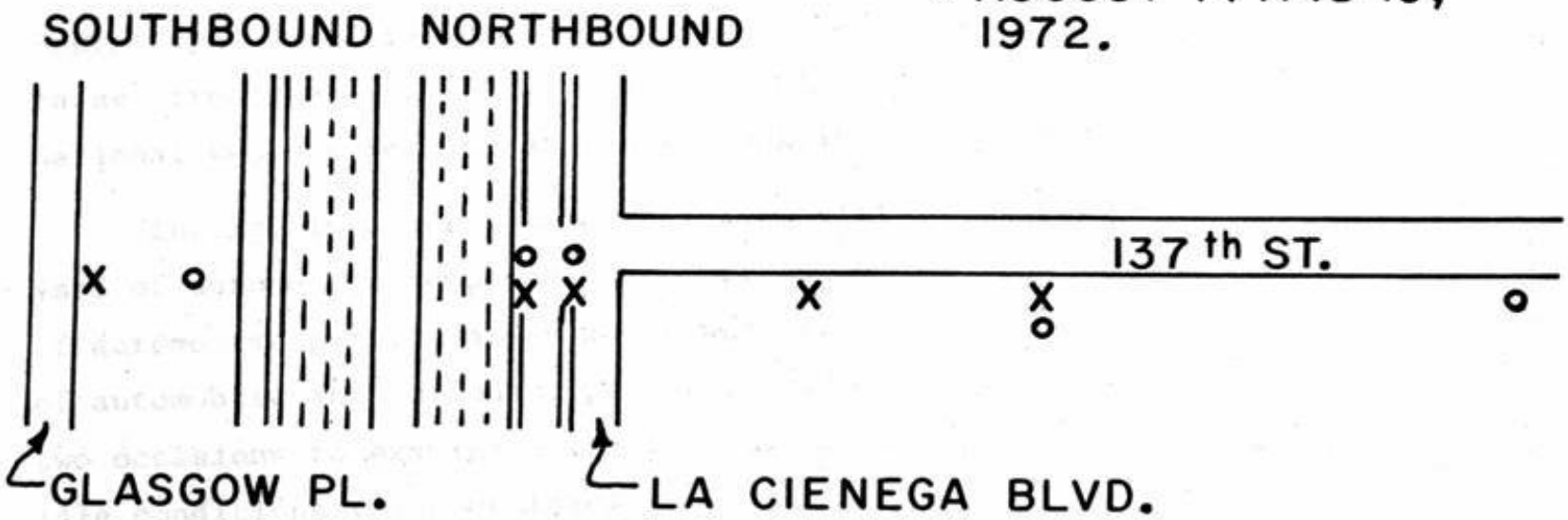


Results for the Santa Monica freeway – also used by US EPA for their model





IMPACTOR SITES
X JUNE 29, 1972.
o AUGUST 14 AND 15, 1972.

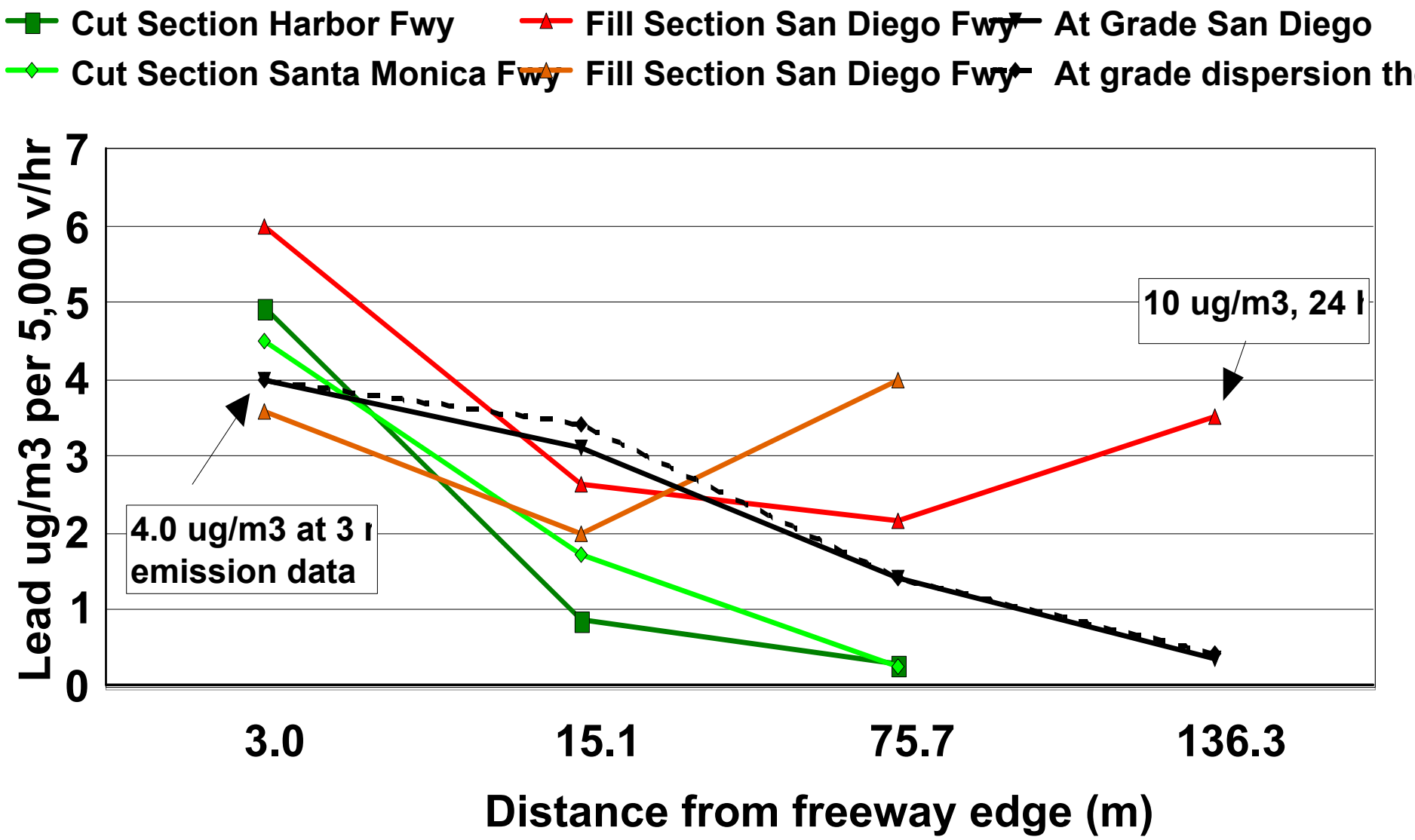


SITE #4 (SD)

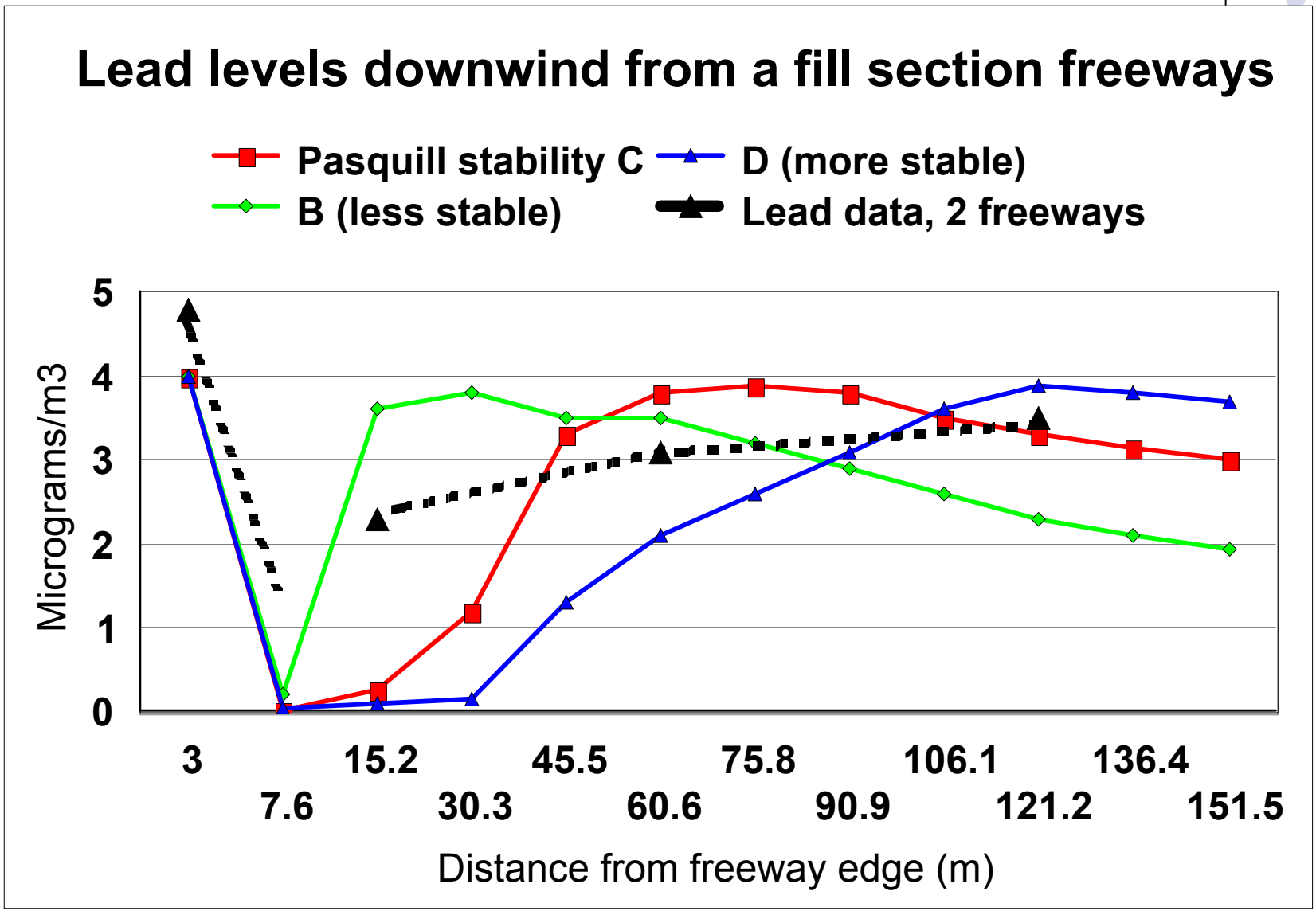
SAN DIEGO FREEWAY NEAR 137 th ST.
6/29/72 and 8/14-15/72

Lead Levels Downwind of Los Angeles Freewa

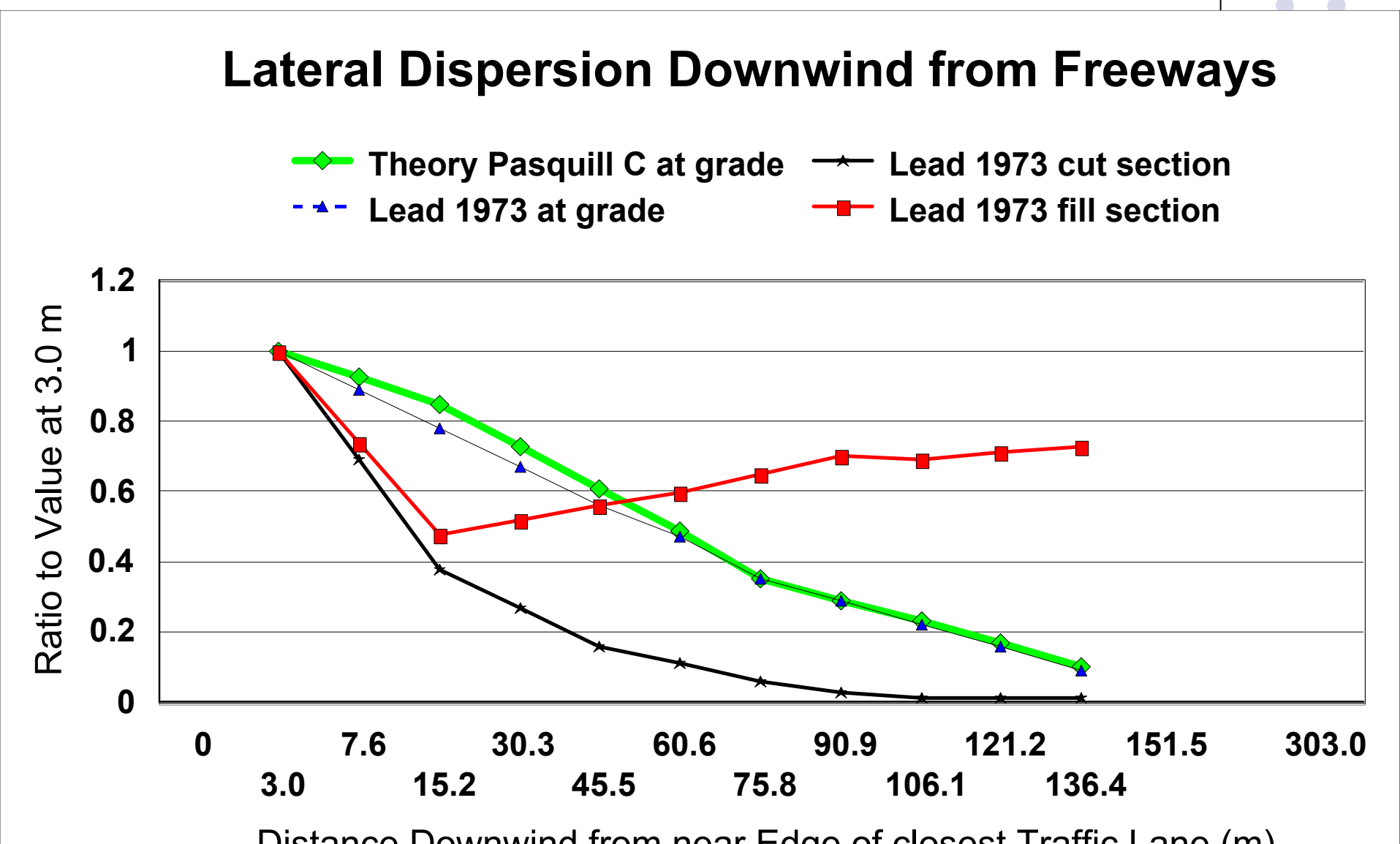
Normalized to 5,000 v/hr, lateral winds > 2 m/s



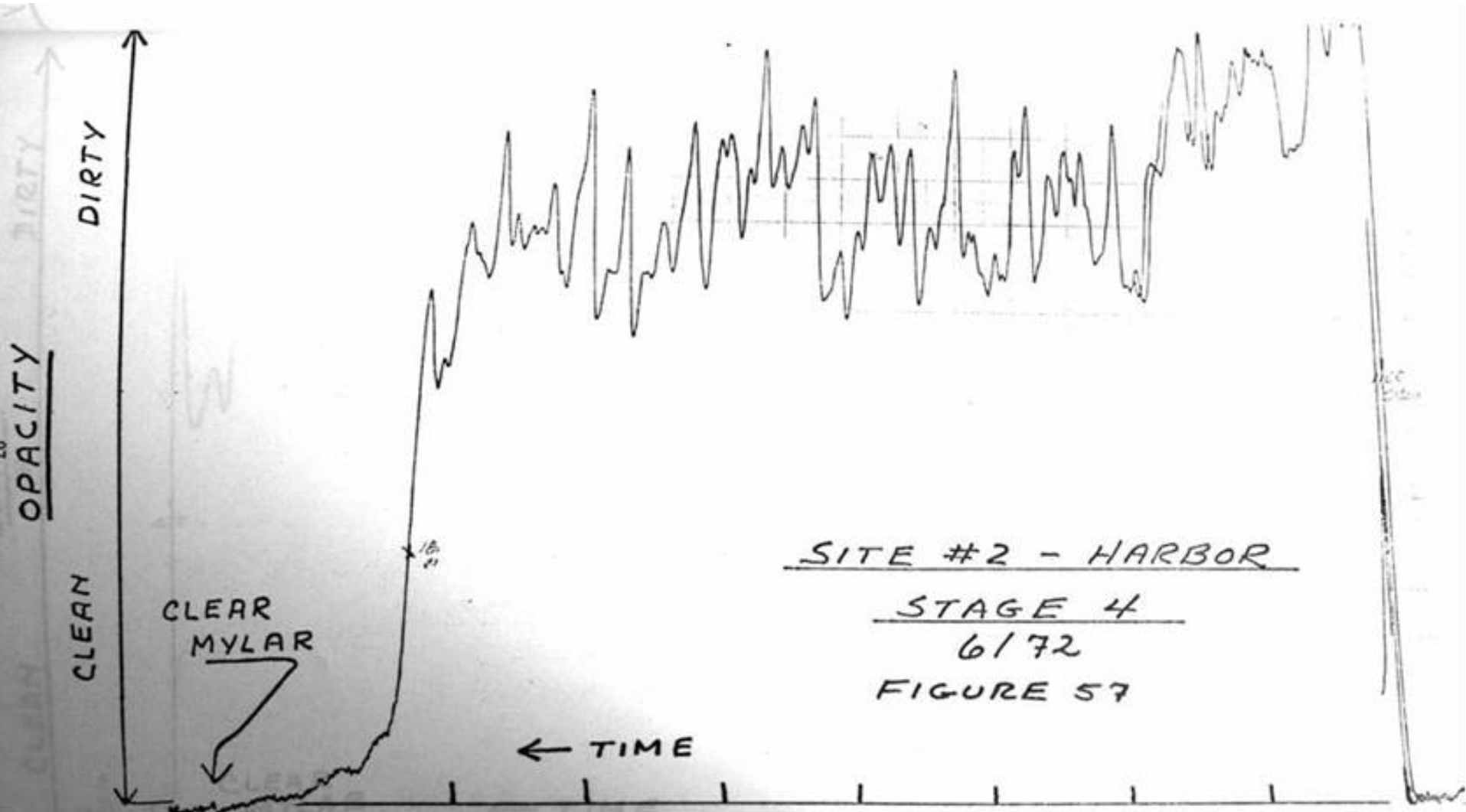
Theory versus Experiment, fill section freeways

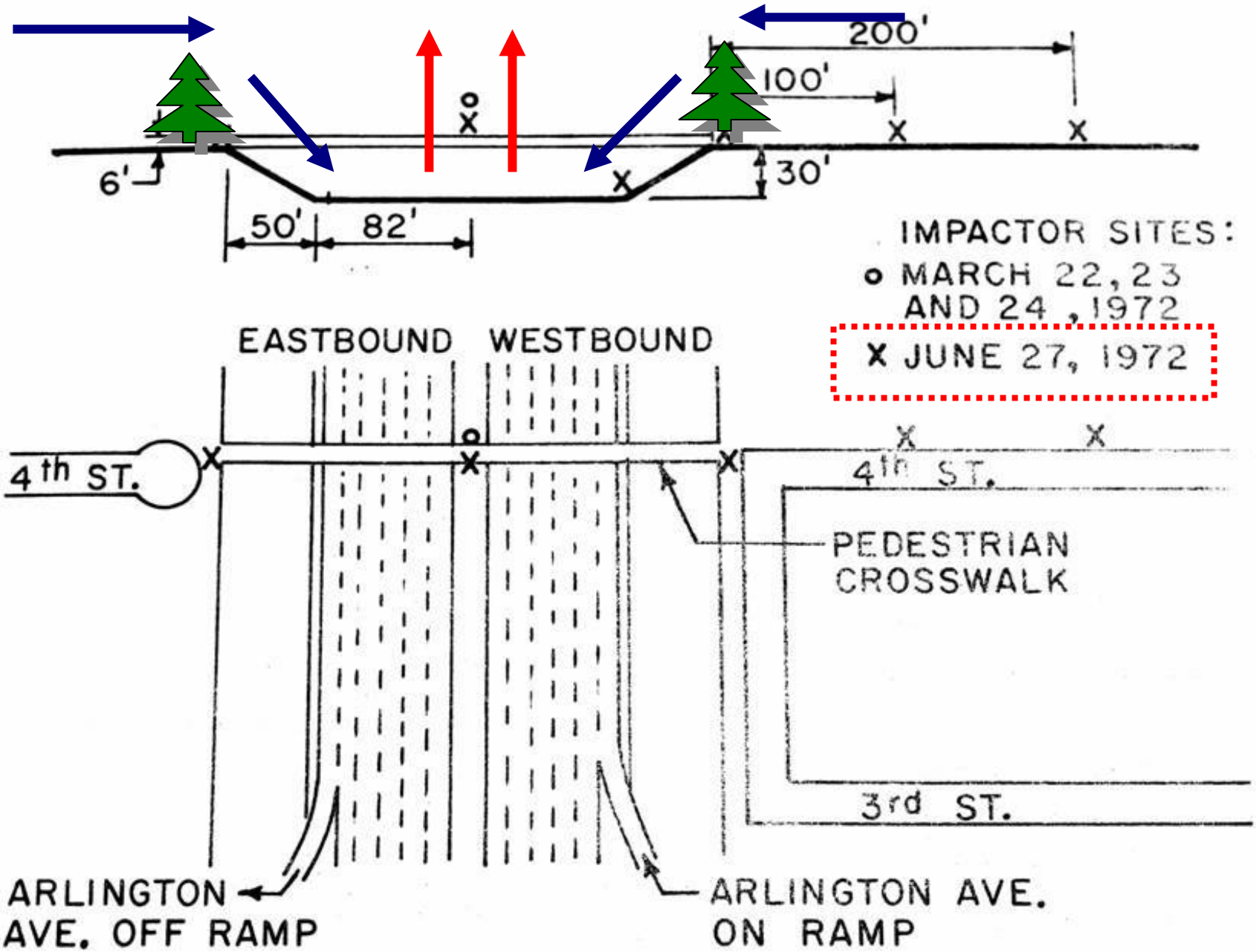


Lateral transport – at grade, cut and fill



Cut section freeway - Opacity versus time – < 2.0 microns, high resolution; waste heat as a self-cleaning mechanism for freeways.




200'
100'
6'
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IMPACTOR SITES:
o MARCH 22, 23 AND 24, 1972
X JUNE 27, 1972
EASTBOUND
WESTBOUND
4th ST.
4th ST.
PEDESTRIAN CROSSWALK
3rd ST.
ARLINGTON AVE. OFF RAMP
ARLINGTON AVE. ON RAMP

"To separate the effect of the planting from the freeway configuration would be a great mistake" (Cahill et al, ARB 502,1974)

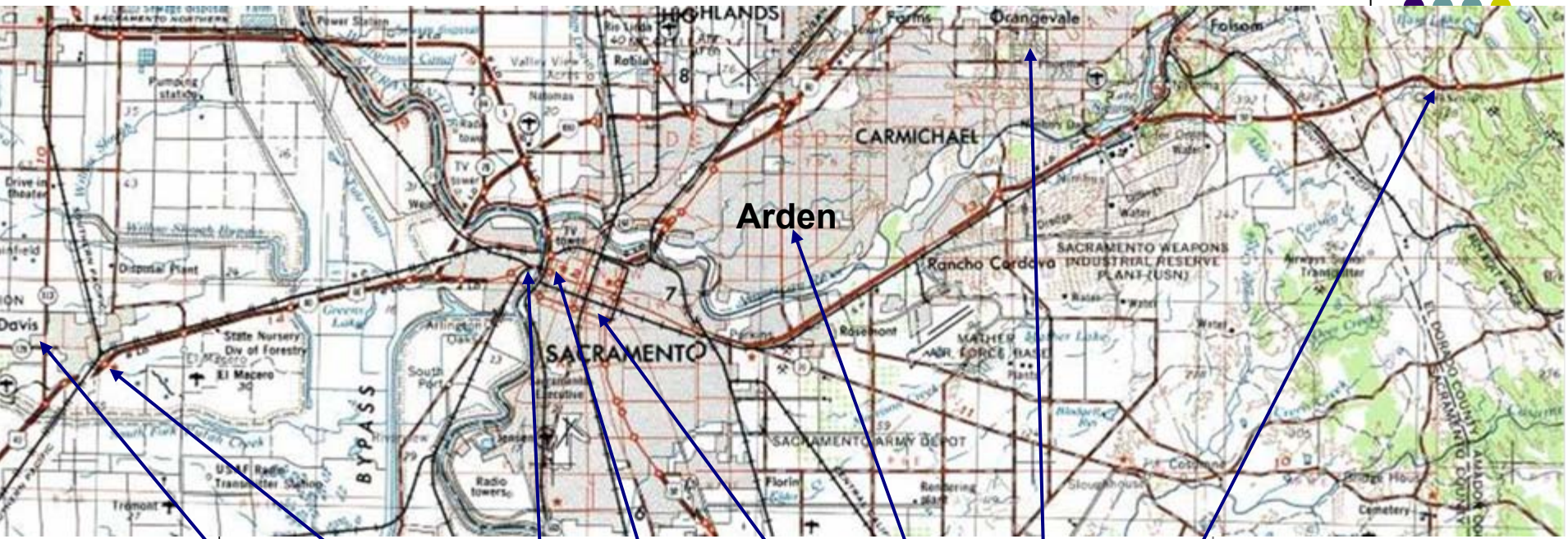
- "The embankments of the cut section freeways were heavily planted."
- The Santa Monica cut-section site had "a dense thicket of bushes ~ 20 feet high at the crest of the embankment hard against the right of way fence."
- The Harbor cut section freeway site " was similarly planted, with eucalyptus and bushed extending higher than 30 feet on the downwind site"
- "The thickets were quite dense, and effectively cut the wind in their lee."

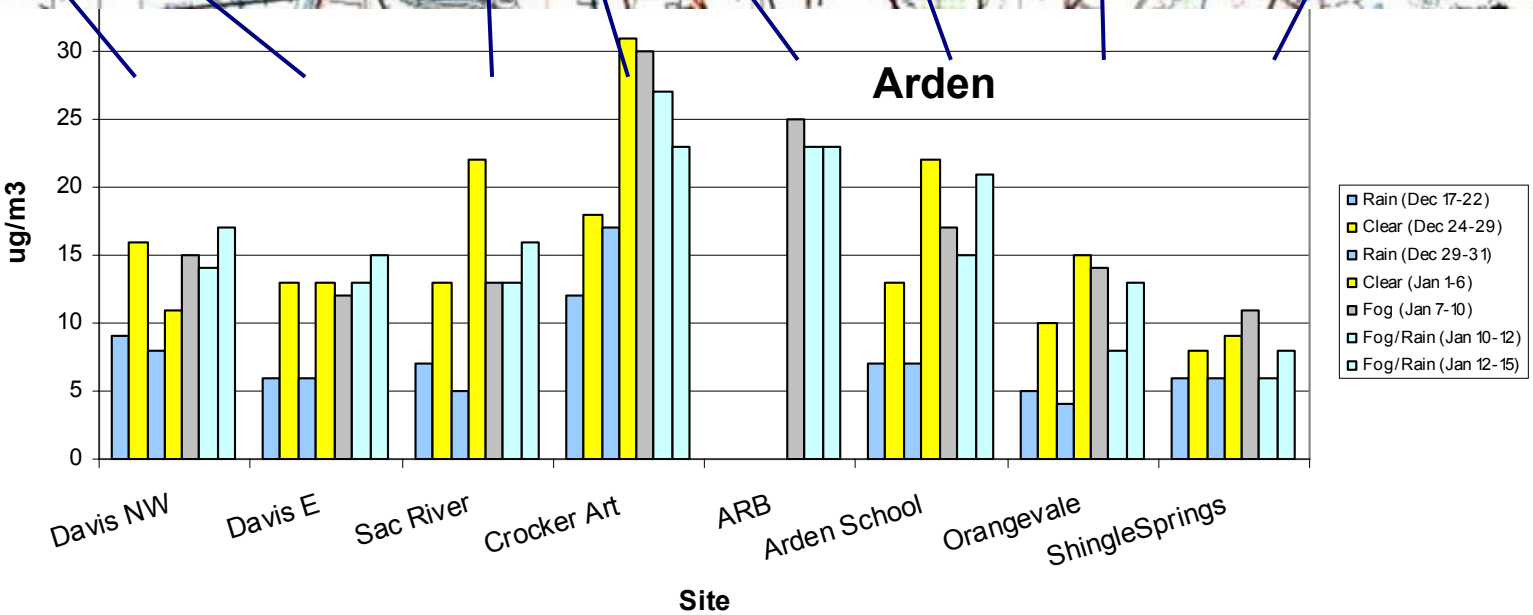
How did the Watt Ave. project happen?

We (Amer. Lung Assoc Health Effects Task Force) were worried about freeway impacts.

- In 2001, the HETF sponsored a study of the spatial and temporal patterns of aerosols at 9 sites upwind and downwind of our major freeway, Interstate 5 in Sacramento (circa 175,000 v/day, 10% trucks)
- This was possible because of the completion of a major National Science Foundation study in Asia that made available over a dozen continuously recording sizing impacts called DRUMs.
- The study lasted 6 weeks with data for mass in 8 size ranges every 3 hours (about 18,000 values).
- At the last minute, a sampler was added at Arden Middle School, directly downwind of Watt Avenue, (circa 65,000 v/day, 1.5% trucks) in response to school district concerns.

What did we find?





Map of Arden Middle School at Watt Avenue

Watt Ave Traffic – 15 m from school

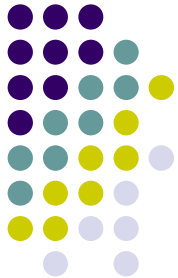
Stop light – not in any California models

California Air Resources Board analysis data/models: no threat to students from Watt Ave!

- Only considered diesel exhaust; few (circa 1.5 %) diesels on Watt Ave
- Model was based on free flowing traffic, and did not consider the stop light
- ARB only used $PM_{2.5}$ 24 hr filters
- ARB was unable to see any diesel exhaust at school (elemental carbon)
- What was left of TACs was benzene, which is regional in nature

HETF data unexpected fine mass –

mis-tuned natural gas water heater – fixed in 30 min!

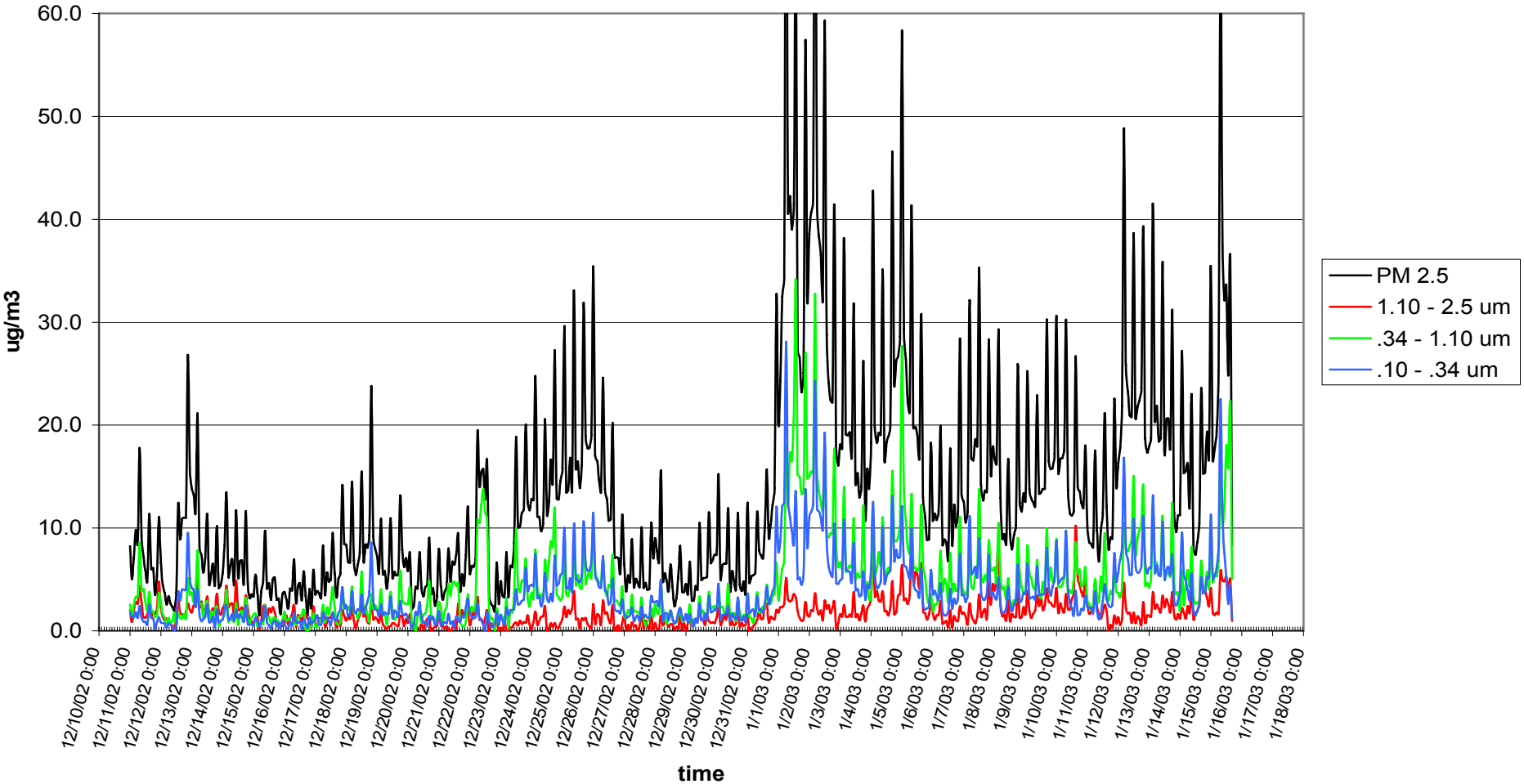


Sacremento Transect Study

12/12/02 - 1/16/03

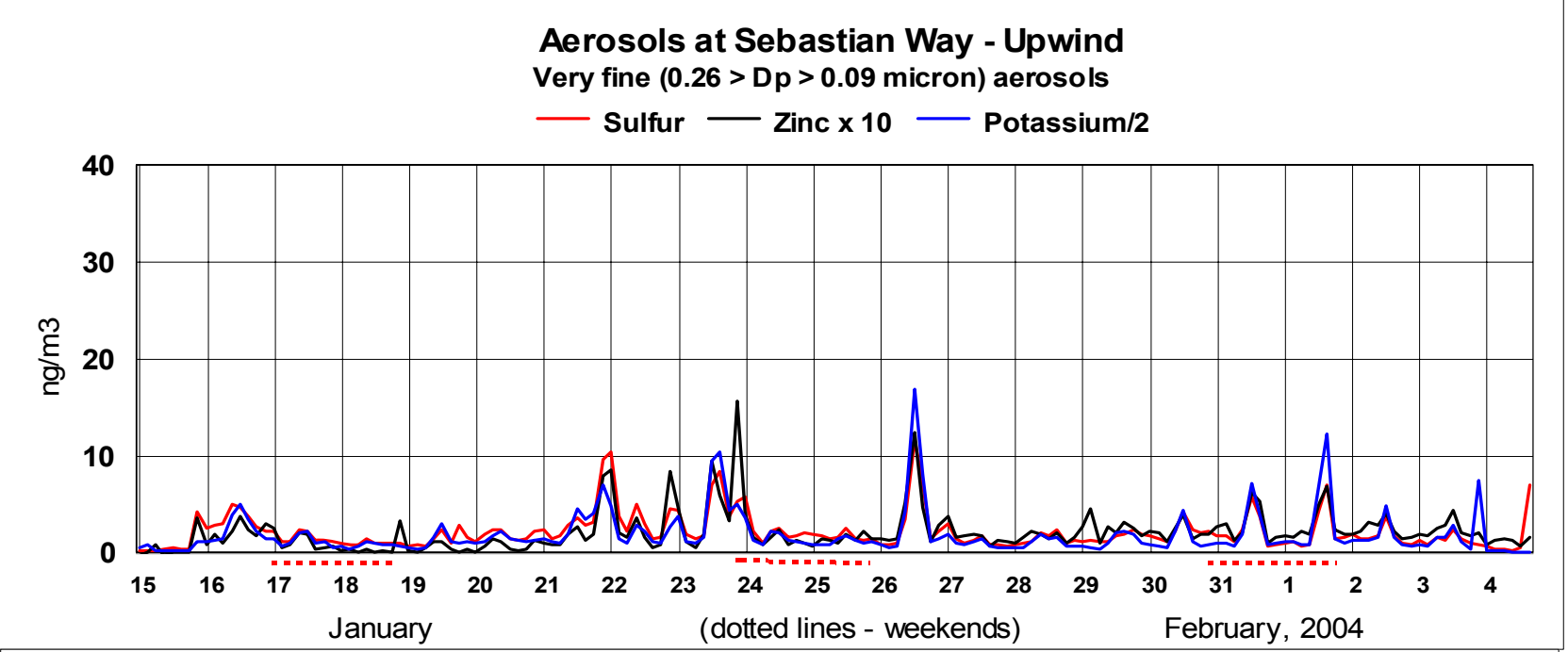
Figure 15 $PM_{2.5}$ mass and 3 sub-components, Arden Middle School site

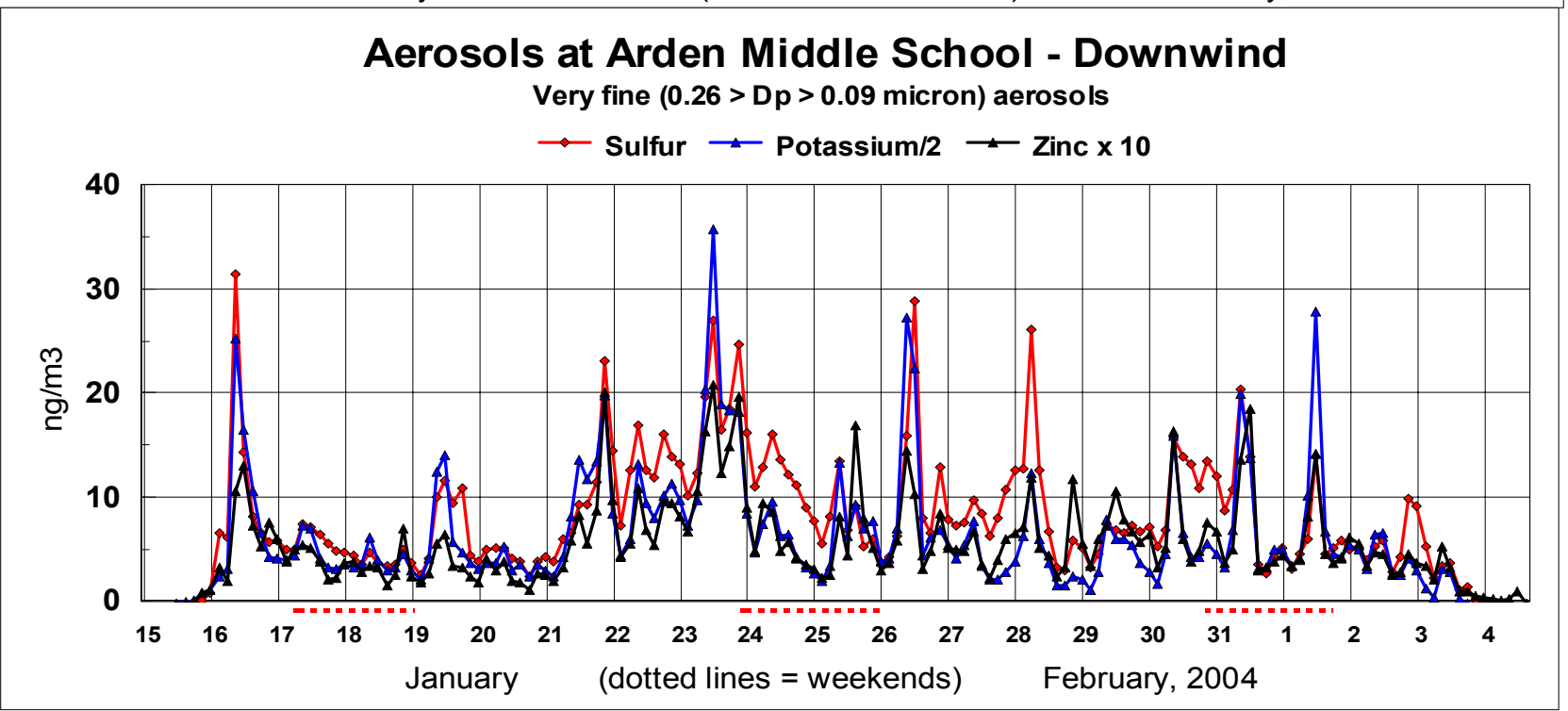
Arden Middle School



Sliding Box integration and Line source dispersion

Parameter	Units		I-5 at Q St.	I-5 at Q St		Watt Avenue	Watt Avenue.
			cars	trucks		cars	Trucks
Emission rate	mg/km		14	135		14	135
Box volume							
Height	m		3.5	3.5		2.5	2.5
Width	m		60	60		40	40
Length	m		1600	1600		1600	1600
Volume	m^3		336,000	336,000		160,000	160,000
Traffic	v/hr		7900	325		3800	53
averaging			AADT/18	AADT/24		AADT/18	AADT/12
speed	km/hr		72	72		32	32
Vehicles, box			176	7		190	3
Emissions/min	mg		3932	1516		4256	572
Conc. box/min	$\mu g/m^3$		11.7	4.6		26.6	3.6
Wind velocity	m/s		2	2		3	3
translation	s		30	30		13	13
Fraction/min			0.50	0.50		0.22	0.22
Conc./highway	**$\mu g/m^3$**		**5.8**	**2.3**		**5.9**	**0.8**


Aerosols at Sebastian Way - Upwind
Very fine (0.26 > Dp > 0.09 micron) aerosols
Sulfur
Zinc x 10
Potassium/2
ng/m3
40
30
20
10
0
15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4
January
(dotted lines - weekends)
February, 2004


Aerosols at Arden Middle School - Downwind
Very fine (0.26 > Dp > 0.09 micron) aerosols
Sulfur
Potassium/2
Zinc x 10
ng/m3
40
30
20
10
0
15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4
January
(dotted lines = weekends)
February, 2004

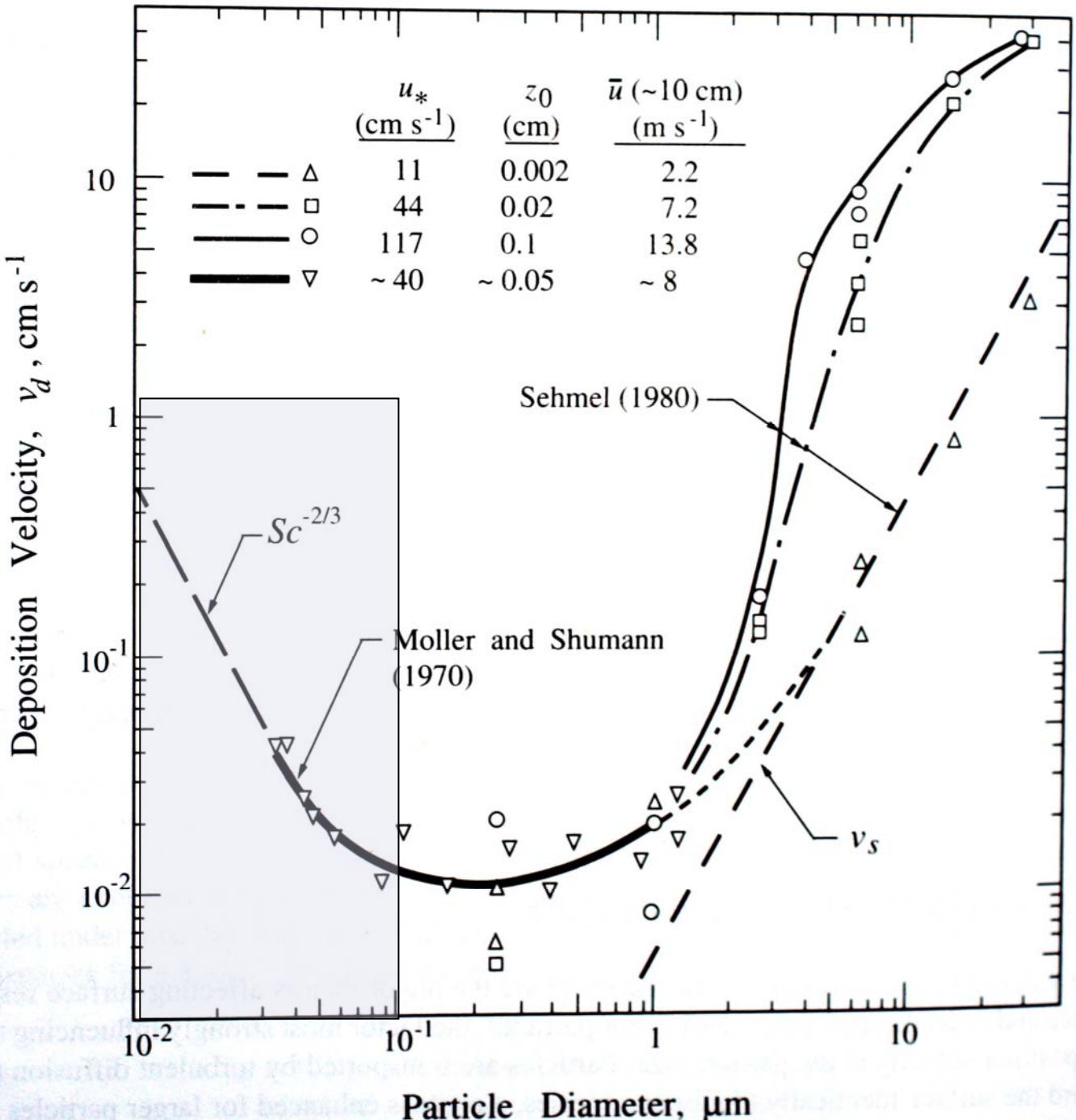
Result – Very fine/ultra fine mass at Arden Middle School

Site	Date	Very fine (0.26 – 0.09 μm)	Total Diesel/Car (0.30 – 0.00 μm)
Arden (theory, near Watt)	**Gertler et al 2002 cars and trucks**		*6.7 μg/m^3*
Arden (theory, near Watt)	**Using Zn ratio from DRI diesels**		*5.4 μg/m^3*
Arden roof (15 m from Watt)	January, 2006	4.0 μg/m^3	7.0 μg/m^3
Arden indoors	January, 2006	1.0 μg/m^3	1.8 μg/m^3
Arden roof (40 m from Watt)	January, 2004	1.3 μg/m^3	na
Crocker Art (100 m from I-5)	Dec.-Jan., 2001/2	4.1 μg/m^3	na
Fresno 1st Street	Dec, 2001	4.2 μg/m^3	na

Table 2 Measured mass values for very fine mass ($0.26 > D_p > 0.09$) μm and total diesel, which adds measured ultra fine mass (<0.09 μm) and a portion of larger particles seen as in the DRI diesel tests.

Mitigation via vegetative capture - theory

- Very fine (< 0.25 μm) and ultra fine (< 0.1 μm) diameter particles have suspected health impacts via several mechanisms including -
  - Insoluble ultra fine particles in the lung and heart
  - Carcinogens in the lung
- Very fine (< 0.25 μm) and ultra fine (< 0.1 μm) diameter particles have relatively high removal rates via diffusion if a surface is close
- Vegetation can provide such a surface

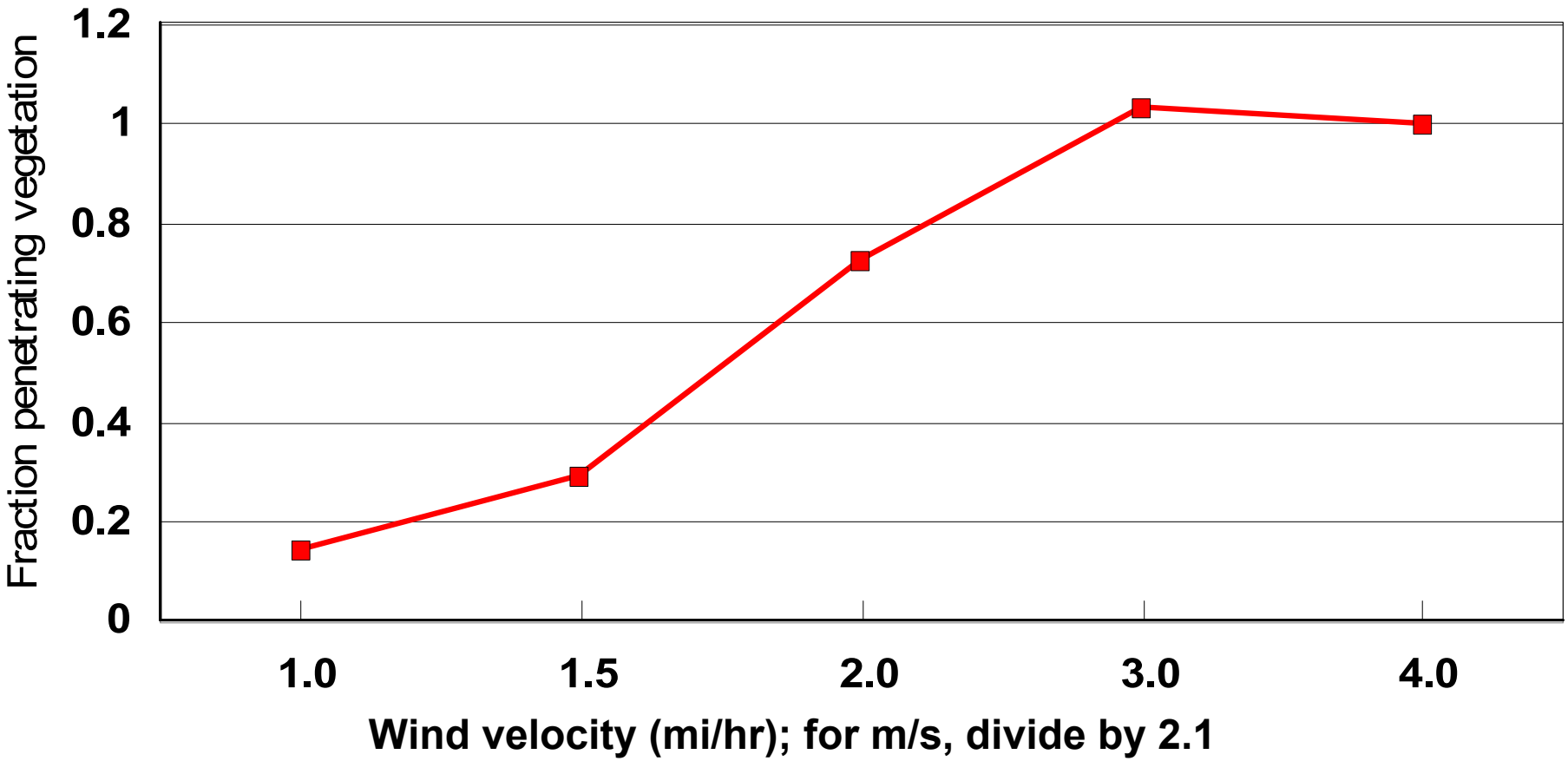


Bottom line:

Very fine and ultra fine particles can be preferentially removed by diffusion to surfaces

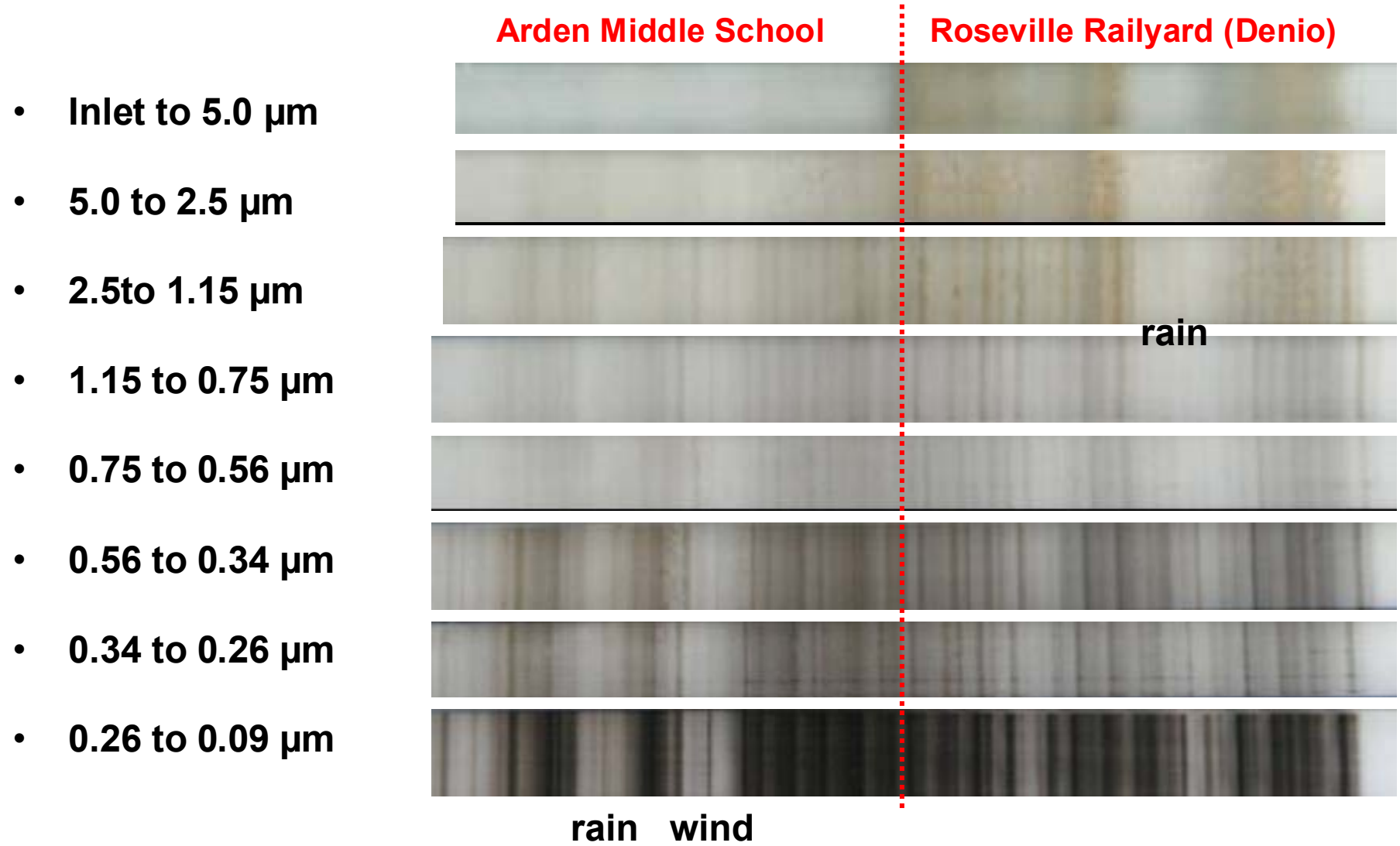
Mitigation of very fine and ultra fine particles by vegetation (preliminary: ongoing HETF project)

Removal of very fine particles in redwood vegetation HETF/UC Davis Tunnel Studies

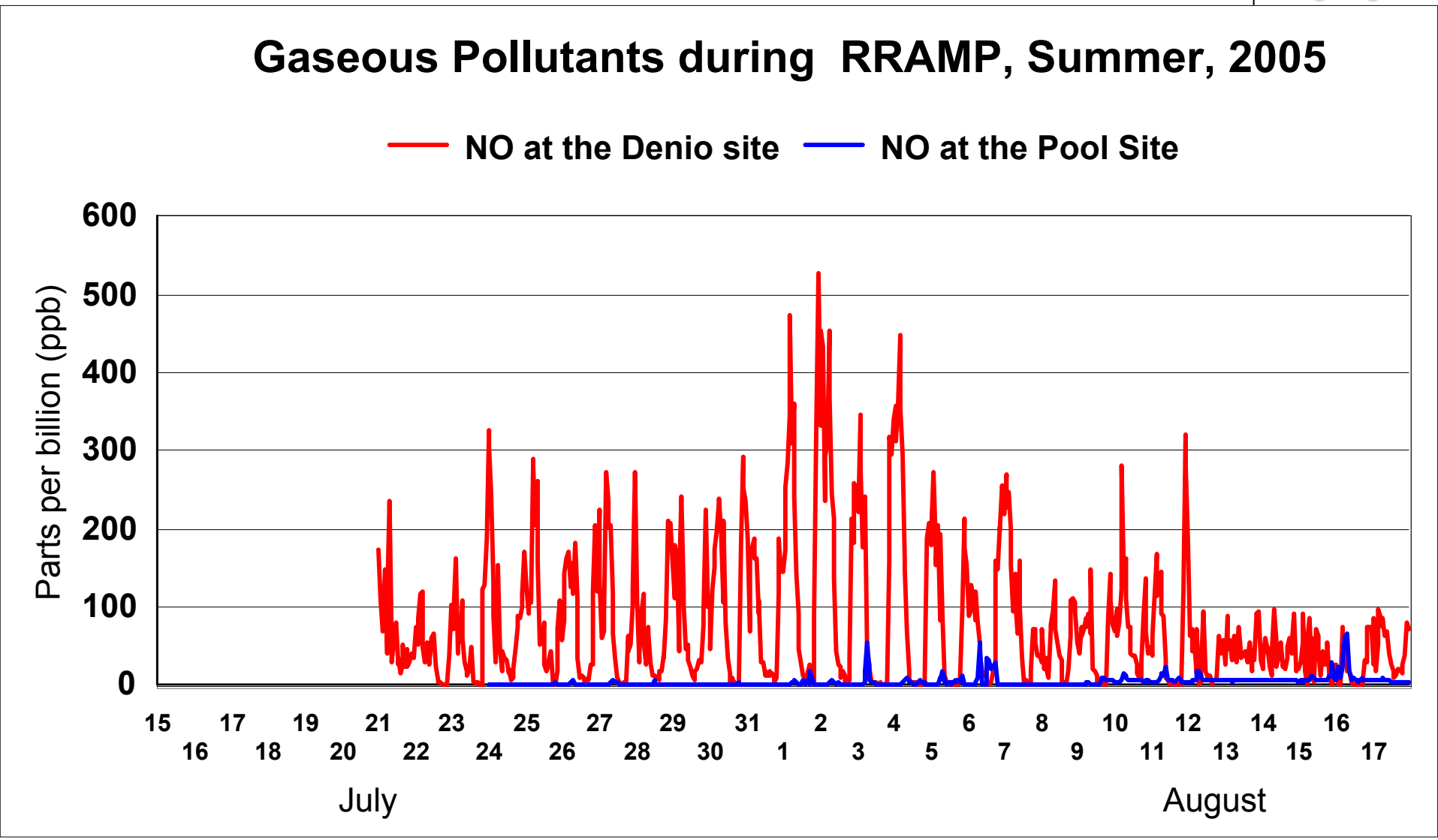


Arden Middle School/Roseville Railyard Aerosols

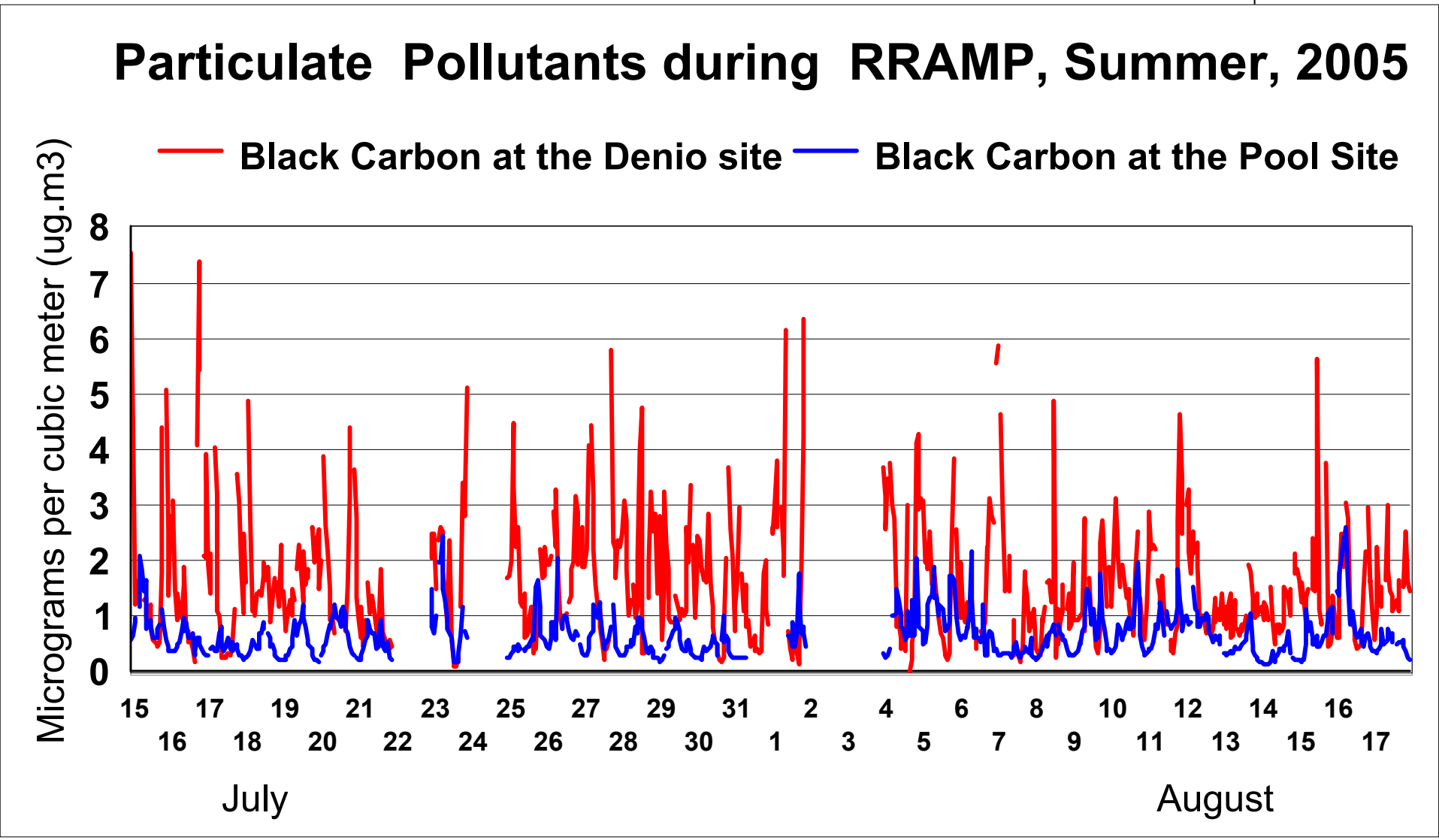
DELTA Group 8 DRUM, true color photo, white background



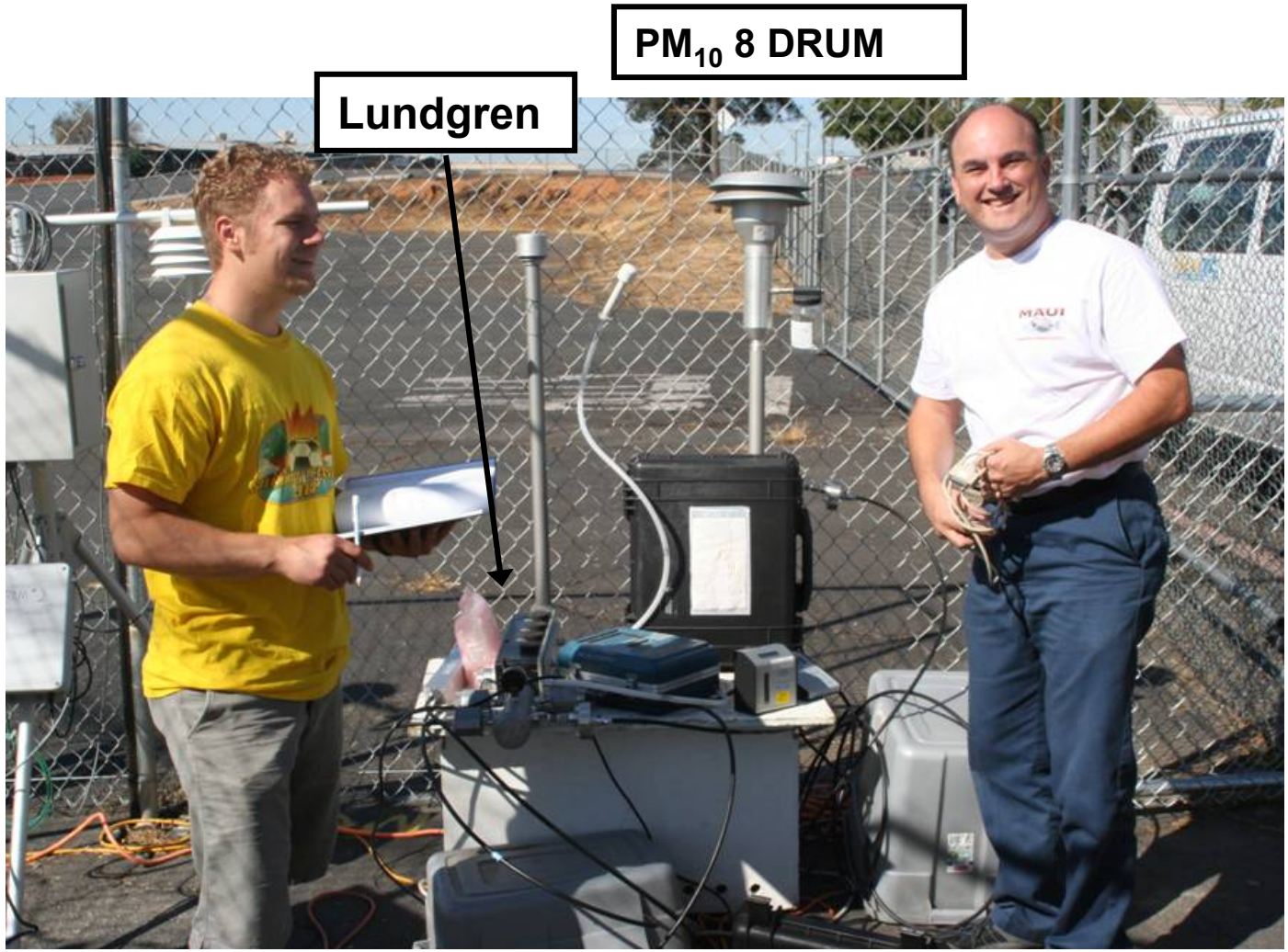
RRAMP Monitoring Results



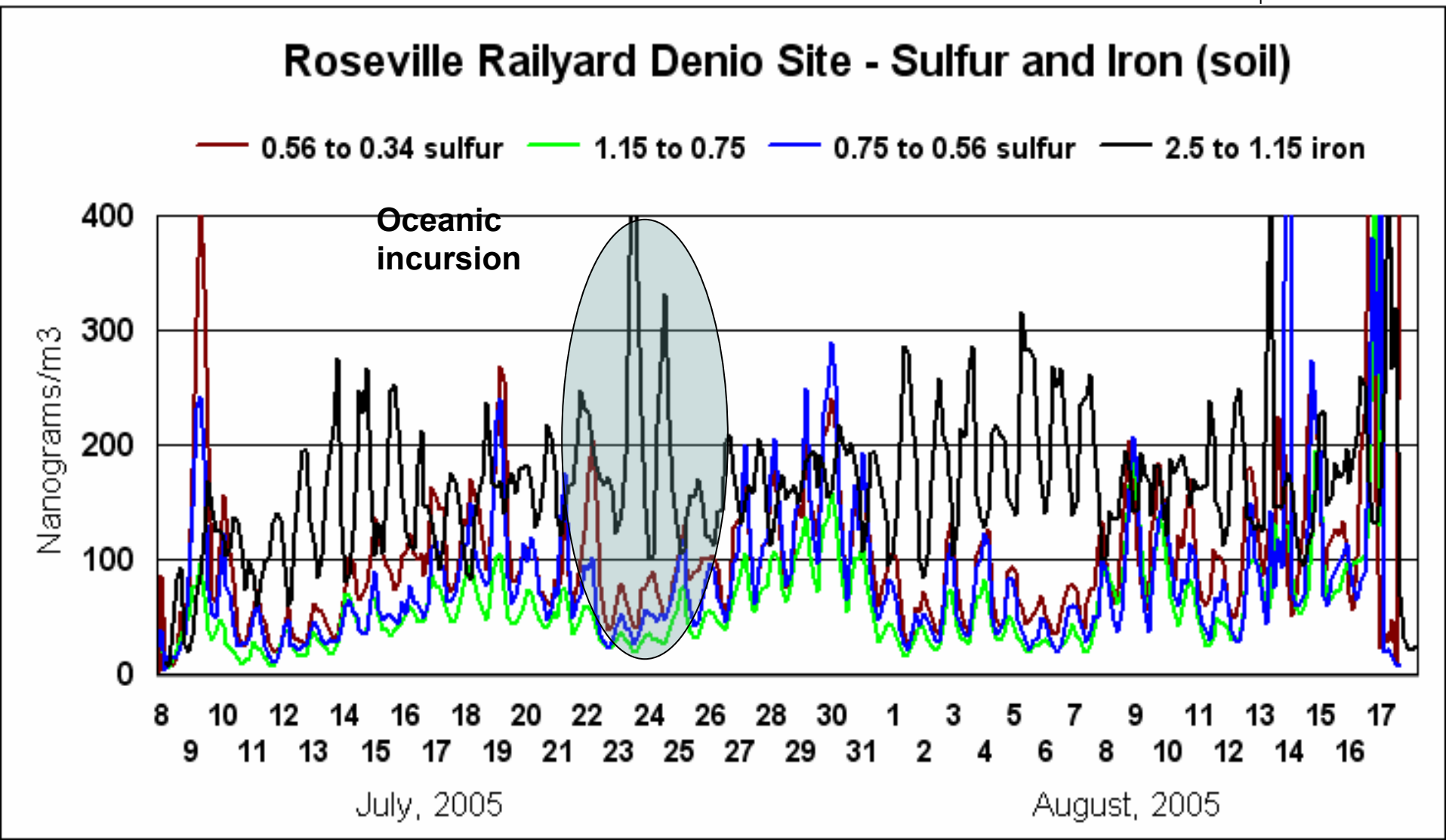
RRAMP Monitoring Results



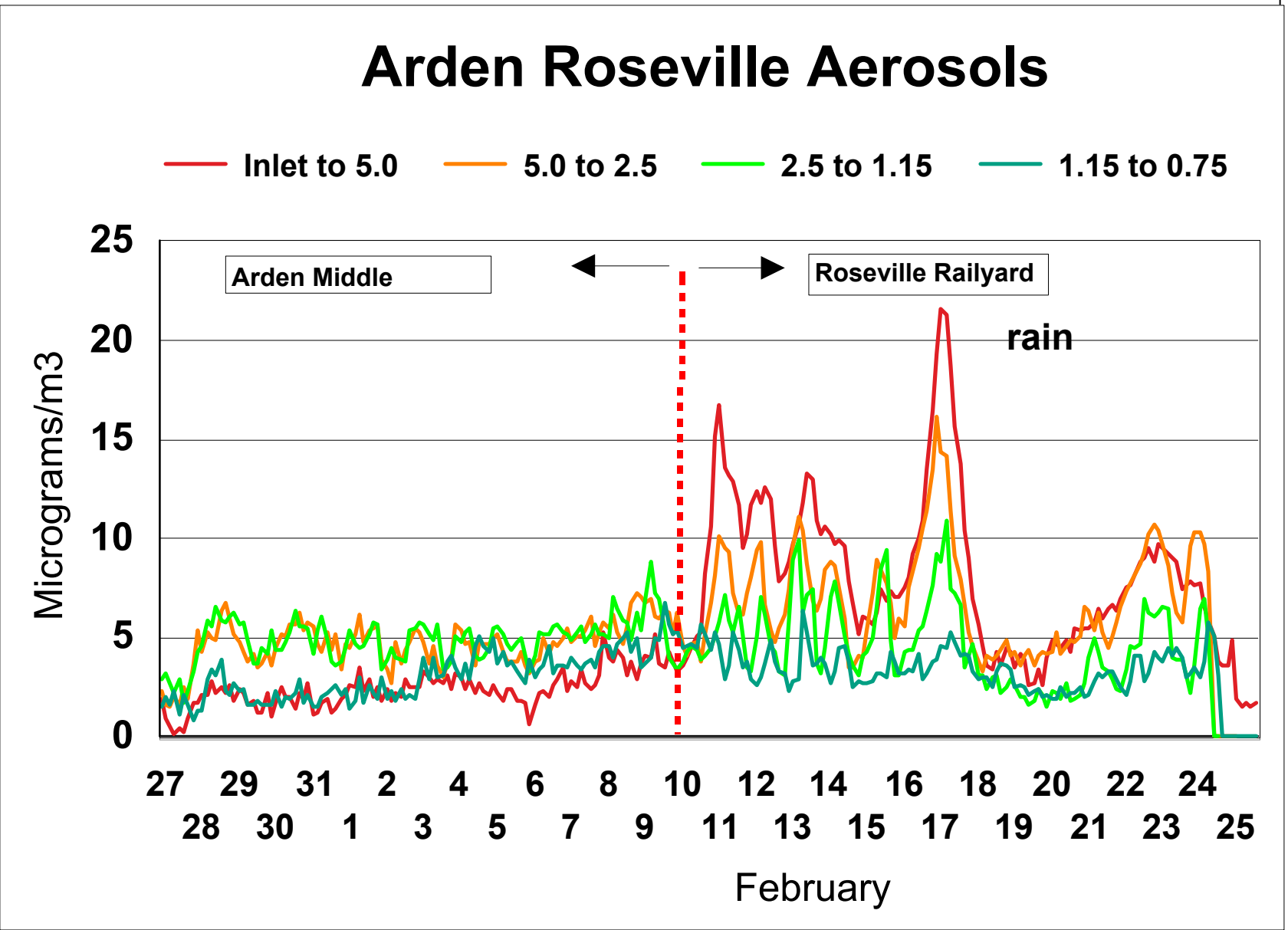
Summer, 2005 sampling array (Sept. 27, 2005) with Nick Spada and David Barnes



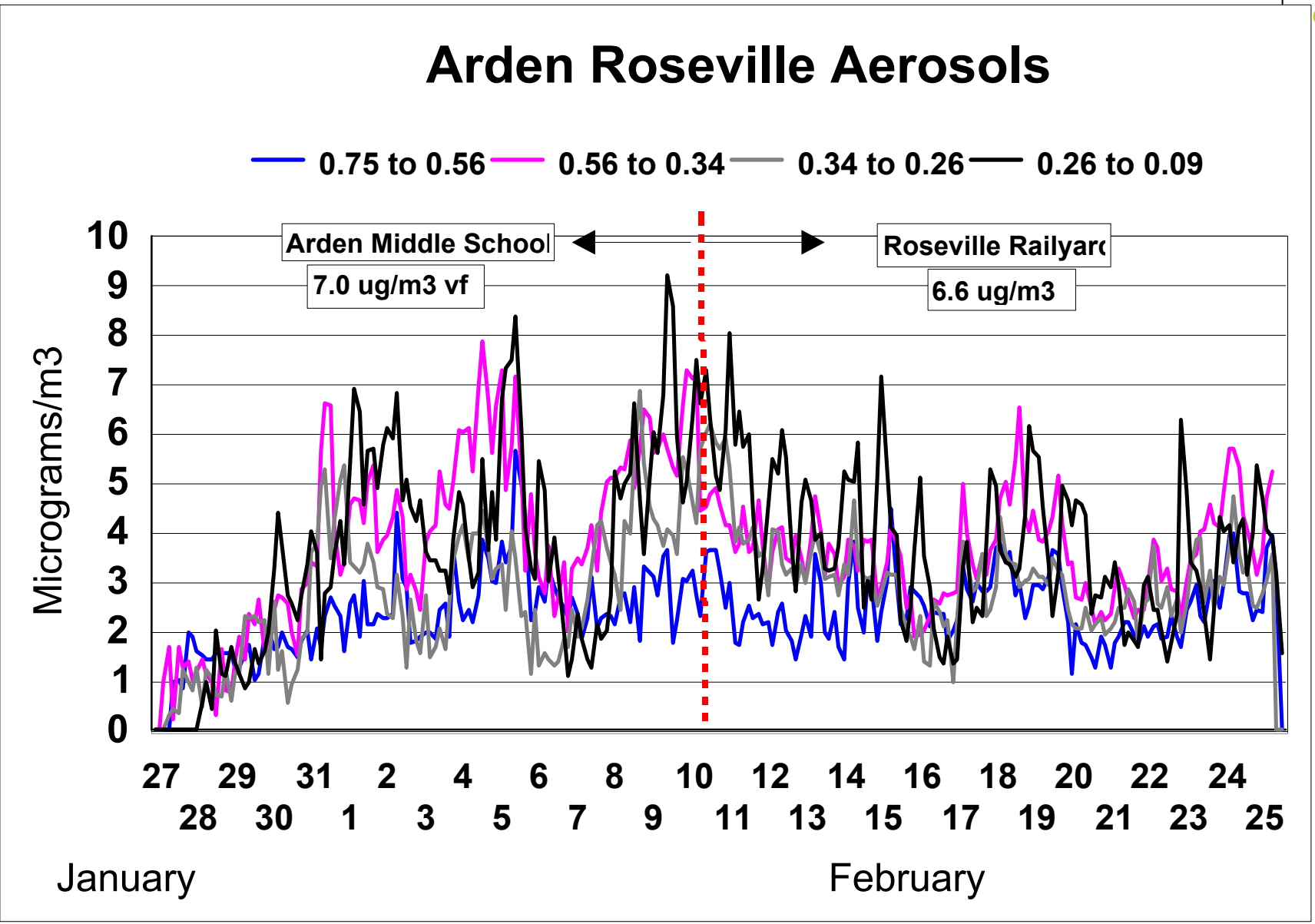
Sulfur (nighttime) and soil (daytime) are often anti-correlated



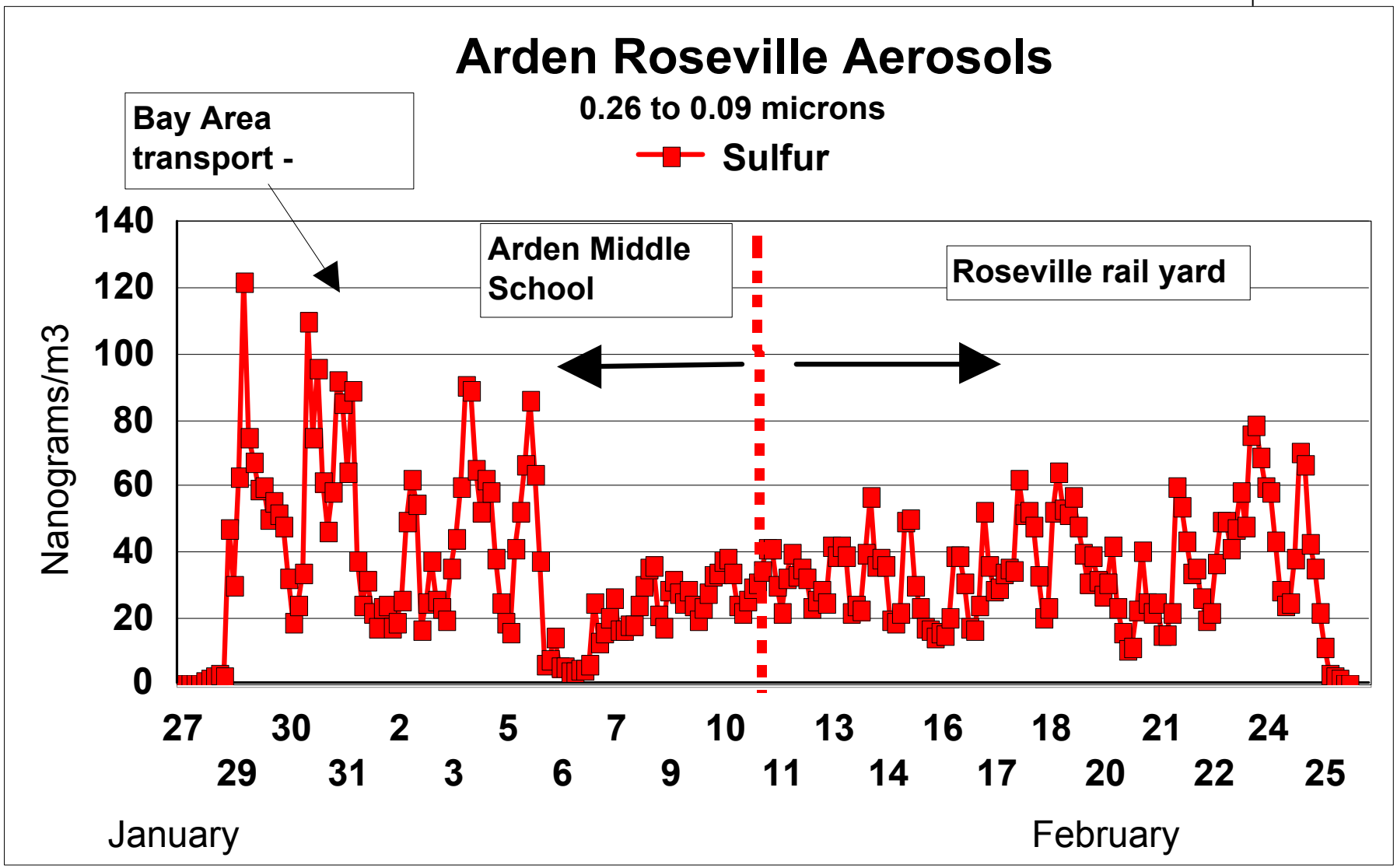
Mass in the coarser fractions



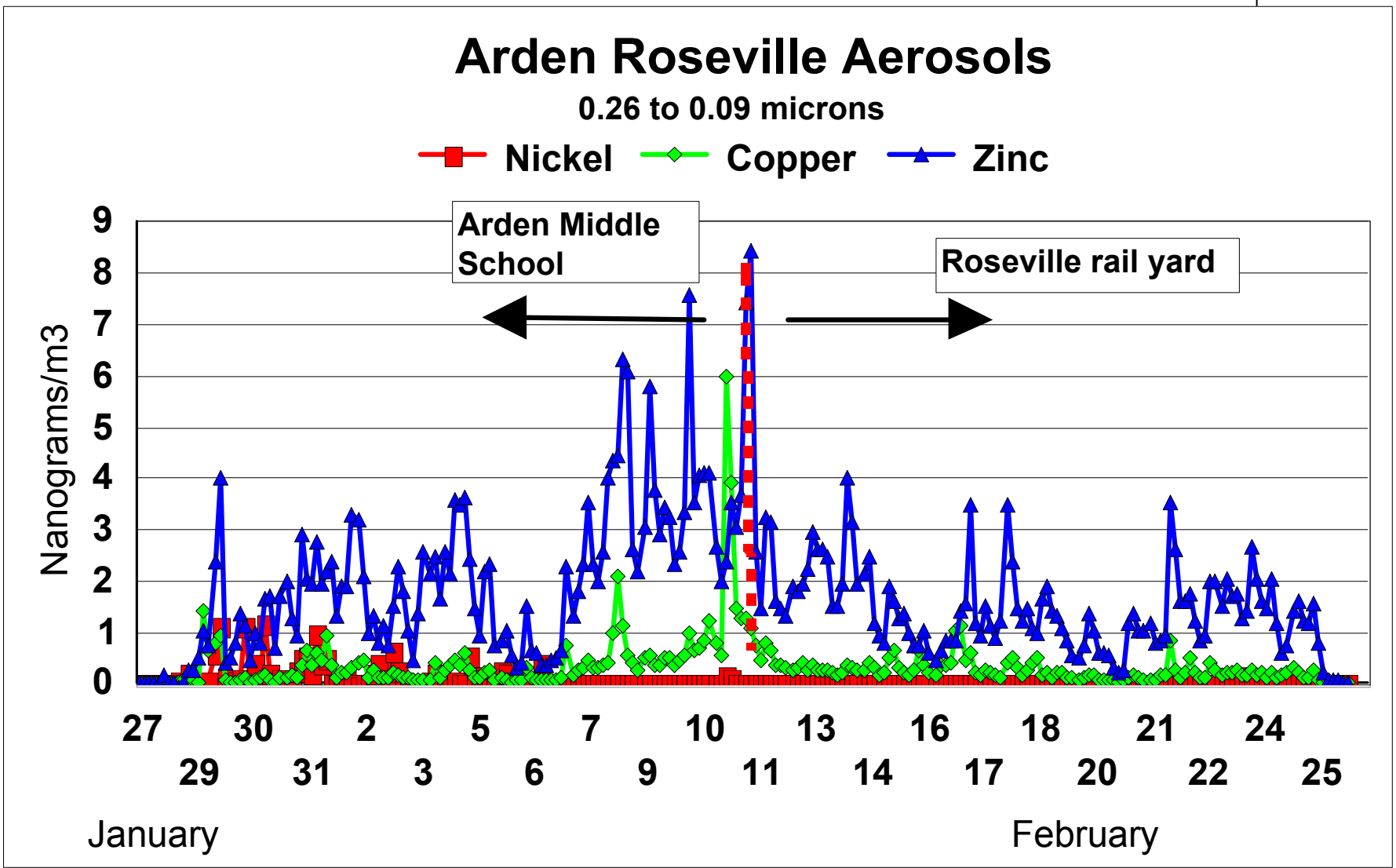
Mass in the finer fractions



Comparison of composition: Arden Middle vs. Roseville rail yard



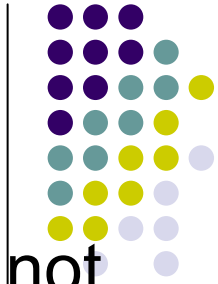
Comparison of composition: Arden Middle vs. Roseville rail yard



Summary -

- Roadways in residential areas are the overwhelming contribution to all California Toxic Air Contaminant (TAC) impacts statewide
  - Most vehicular aerosols are from cars
  - Car exhaust is more toxic than diesel exhaust per unit mass
  - Study in progress – speciated organics vs. size at Arden Middle School
- Freeways are less of an impact because -
  - There are fewer freeways than secondary roadways,
  - they generally better buffered from residences,
  - the high traffic velocities induce better mixing, and
  - the vehicles tend to be cleaner.

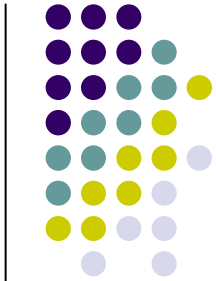
Mitigation options – we must move in parallel on all of them!



- Since roadways, traffic, and toxic emissions are not going to go away tomorrow – can we mitigate?
  - Roadway source improvements, including
    - Cleaner engines, fuel, and new artificial lubricating oils
    - Removal of gross emitting vehicles (~ 3%) from roadways (worst 1% vehicles = ~ 30% of vf/uf mass)
    - Reduced traffic via transportation alternatives
  - Roadway design options – "Complete Streets"
    - Highway design; cut section, tunnel (cleaned!)
    - Pollution barriers – use waste heat and vegetation to loft and trap uf particles
  - Reduced Transport efficiency to residences
    - Distance!
    - Pollution barriers
  - Residential indoor air quality improvement
    - Positively pressurized filtered receptors

Acknowledgements

- The Breathe California Health Effects Task Force volunteers
  - Includes ARB/DHS CCEHS, ARB diesel toxics leaders
  - UC Davis DELTA Group technology
- The local Sacramento Metropolitan Air Pollution Control District
  - Ongoing toxics study at Arden Middle School
- US EPA Region IX (San Francisco)
  - Roseville rail yard (Final Report 6/1/2007)
- The Arden Middle School principal, staff



Mitigation of very fine and ultra fine particles by vegetation (preliminary: ongoing HETF project)

Removal of very fine particles in redwood vegetation HETF/UC Davis Tunnel Studies